

# A LECTURE

THE IMPORTANCE OF A KNOWLEDGE OF

# PHYSICAL SCIENCE

THE MEMBERS OF ALL PROFESSIONS,

BEING INTRODUCTORY TO

A COURSE OF LECTURES ON THE APPLICATION OF  
ACOUSTICS TO THE DISCOVERY OF  
CHEST DISEASES,

ERED TO THE MEMBERS OF THE MEDICAL PROFESSION, AND OF  
THE PHILOSOPHICAL INSTITUTION, AT BIRMINGHAM.

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THIS Lecture has been printed at the request of several Friends who were present at its delivery; and is intended for circulation among such young persons as are on the eve of entering a Profession, but more especially among those who have been in the habit of attending my Clinical Lectures at the Birmingham Dispensary.

It contains a few hints for their consideration, thrown loosely and hastily together; and therefore can only be regarded as offering a mere outline of the subject the filling up of which would swell these pages into a voluminous work, and would require the devotion of more time than I can command, and the exercise of more ability than I possess.

If its perusal shall excite an interest in the minds of any such persons, and shall encourage them in laying a solid foundation of scientific knowledge and religious principles for the formation of their professional character, I shall be highly gratified and amply rewarded.



# LECTURE

## ON THE IMPORTANCE OF A KNOWLEDGE OF PHYSICAL SCIENCE.

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IN directing our attention to the practical application of any one branch of Physical Science to professional purposes, we are naturally led to enquire whether the study of Natural Philosophy in general, may not prove beneficial to members of *all* professions. To this enquiry I would address myself on the present occasion, not so much with a hope of laying any new or striking arguments before those who have previously considered the subject, as of arousing those who have hitherto been indifferent to it. Had it received that degree of attention to which it is entitled, I cannot but think that the important bearings of this Science upon all classes of society, would long since have been universally acknowledged, and that ample provision would have been made for its cultivation in our public schools, and a certain knowledge of it required in the examination for degrees at our great Universities.

We can hardly suppose that the classic groves would have proved less inviting to the student, had they been traversed by the stream of Science which reflects on its bright surface such varied and beautiful forms of Divine wisdom and goodness—that his imagination would have been less fitted to follow the bards of old, in their lofty aspirations and poetic visions, because new fields had been opened to it, by the contemplation of natural phenomena—that his mind disciplined to trace the causes and mutual dependance of these phenomena, would thereby have been rendered less capable of

entering into the subtle reasonings of the Philosophers of Greece and Rome—or that he would have been less roused by the sublime eloquence of their Orators, because he had been wont to listen to that Voice which speaks in all the operations of Nature. Nor can we suppose that his estimate of all that is noble and great in man would have been less just, had he been habituated, not merely to scan the actions of the warrior and the statesman, but also to follow those master spirits, who, at different times, have unravelled the laws by which the Universe is governed.

It is with pleasure, however, that we hail the commencement of improvement. The University of London has included Natural Philosophy among the subjects, a certain knowledge of which, is required from the candidates for medical degrees; and it is to be hoped that this example will soon be followed by other public bodies possessing the privilege of granting such degrees. In King's College, London, and in the University of Durham, classes have lately been formed for the purpose of educating students in the art of civil engineering, but in which all can acquire a sound knowledge of Physics; and in King Edward's school, in this place, measures have already been taken for giving instruction in some of the elementary branches of Natural Philosophy, which will doubtless be still further extended, as circumstances shall permit. Above all, in the University of Cambridge, a certain proficiency in these subjects is now required from all who present themselves for degrees in arts; while the examination of the aspirants for mathematical honors is such as to elucidate, not merely whether they are possessed of the mathematical knowledge necessary for working out the higher branches of Natural Philosophy, but whether they can and do use this knowledge; in short, whether they are Philosophers as well as calculators.

As a better æra has thus commenced, it may be considered useless to touch upon the subject on this occasion: but, although the light has begun to dawn, the darkness has not been dispelled. There are parts of the globe on which, for a great portion of the year, the sun's rays do not fall; but the moon and stars afford that light which they have borrowed from the great luminary, and thus prevent the horrors of darkness. In a similarly subordinate character, I would

strive to assist those who have begun this work, and borrowing light from them, I would endeavour to increase the points of illumination, and thus bear my humble part in dispelling the darkness that has too long enveloped our systems of education.

I shall address myself principally to Students, in the hope of exciting in them a desire after scientific attainment, while they have time to devote to its acquirement; endeavouring to convince them of its importance to them, as regards both their future character and prospects; and also because this course may in some sort be considered as supplementary to that on Clinical Medicine, which, although interrupted by the preparation of the experiments required for the illustration of the course of Lectures on Chemistry, that I delivered lately to the Members of the Philosophical and Mechanics' Institution, I purpose resuming next year. Indeed the path of clinical instruction is one in which I consider it a duty to persevere, and with which no private engagements should be allowed to interfere; for the higher professional men rise, and the more extended their field of observation, the more imperiously are they called upon to devote some portion of their time to the improvement and instruction of the junior members of their profession, by imparting to them the results of their daily increasing experience. Few pleasures can be greater than those afforded by thus unfolding the enlarged views which are continually opening upon them, and seizing the opportunities offered by such intercourse with their pupils, to encourage in them those feelings of kindness, honour, and liberality, which they would wish to see possessed by those who may one day be placed side by side with them, in the practice of their profession. The beneficial effect produced on the minds of such teachers is truly astonishing; they are constantly stimulated to acute and accurate observation, they are led to ponder over the different cases which present themselves in the course of their practice, and to compare them with each other, watching closely every link in the chain of reasoning and in the deductions from them; and thus not unfrequently, unconnected and floating ideas will become fixed and certain principles. Sometimes they are led into a field of enquiry beyond that to which they had originally intended to direct their researches, an instance of which has occurred in the preparation of these Lectures, out of which has

arisen the discovery of some new facts connected with the theory of Sound.

This Course of Lectures has been opened to the Members of the Philosophical Institution, on account of the growing interest which is taken by all classes of society in physiological subjects, an interest which can hardly be too much fostered and encouraged. For were it to become general, and have the effect of inducing a large portion of educated persons to make themselves acquainted with the general economy of their frame, a vast improvement in the moral and physical condition of the human race might be expected to take place. The attention of such persons would be directed to the bringing up of their offspring, from the earliest age, on an uniform plan in respect to diet, clothing, and moral discipline, suggested to them by their physiological knowledge; whereby the lamentable effects on the health, lives, and disposition of the victims of parental caprice or indulgence, would be in some measure obviated, and a larger number of healthy and vigorous individuals would come to maturity. Seeing somewhat of the connection between the health of the body and that of the mind, and knowing that enervation of the latter must succeed to that of the former, whether induced by over-exertion or by luxurious indulgence; and that, on the other hand, loss of health must sooner or later follow the continuous and uncontrolled exercise of any bad passion, they would be induced to regulate their habits in such a manner as to preserve the mind and the body in a state of healthy equilibrium. But should disease attack them either in their persons or families, they would not be entirely devoid of the means of distinguishing between the empiric and the Philosopher, and would be enabled to assist the latter in carrying out those rational plans of treatment which he might adopt, the success of which often depends quite as much on the intelligence with which they are received and executed, as on the skill with which they have been devised.

It cannot be matter of surprise that many persons should take an unusual interest in the subject of these Lectures, and should desire to know the means whereby the various diseases of the chest are discovered and distinguished from each other, when we reflect that one-fifth of those who pay the debt of mortality, are

the victims of pulmonary consumption alone, that scourge of our large manufacturing towns. How insidious but how sure are the approaches of this devastating malady, gradually entwining its victims in its meshes, until it has woven around them a net from which no earthly power can extricate them! It is not a mere sweeping blast which whirls from the stem the petals of the more than matured flower, but it is the canker in the bud which gnaws around the half-developed leaves, and causes them to drop off almost as soon as their beauties have been revealed to the light. For here Death is dainty and fastidious in the selection of the victims he dooms for sacrifice. He grasps not the aged and infirm, who in the natural order of things lie nearest to his hand, but passes on to the young and beautiful, at the very period when their minds are expanding, and opening to new and fascinating views of prospective happiness. To make the sacrifice complete, the victim, decked with wreaths and garlands, is led to the altar unconscious of his impending fate; for how often in this disease does the eye glisten with unusual brightness, while the cheek is painted with the delicate bloom of the rose, and lighted up with the soft smile of hope that remains till the last! To all but its victim, this fatal malady tells its own tale, when it has reached an advanced period of its development; and although even then it may be wondrously suspended or altogether restrained, yet the extreme rarity of such results forbids our calculating on them with even an approach to certainty. In its earlier stages, however, much, I had almost said every thing, may be done in the way of prevention; who would not then rejoice to learn that there were means of detecting its approaches at such a period as to afford some hopes of their being arrested?

Persons thus interested will see here how the frame of the chest and the organs contained in it, are constructed; how their functions are performed, and the nature of those physical alterations which are produced in them by disease. They will learn somewhat of the laws of Physics, more especially Acoustics, most of which will be deduced from experiments performed under their eyes. They will thus understand in what manner physical alterations in the organs of respiration and circulation give rise to physical signs, which must be interpreted in accordance with the laws which govern matter in general; and will

be enabled to estimate at their true value, the assertions of those who would endeavour altogether to ridicule the application of the laws of Sound to the discovery of disease, or to deny its utility on the score of its difficulty in practice. As to the correctness of the principle, they will have ample means of satisfying themselves, and will find not merely that certain forms of disease *may* give rise to certain alterations of sound appreciable by the ear, but that they *must* do so. As to the difficulty of auscultation, they will remember that excellence is always difficult of attainment, but exertion is not on that account to be discouraged; and they will see that cases may occasionally occur, in which great doubts as to the nature of the disease will arise in the mind of the most skilful practitioner unhabituated to auscultation of the chest, wherein the merest novice in that art could hardly fail to form an accurate diagnosis.

The necessity of a knowledge of the laws of Physics to members of different professions, may be deduced as much from the observation of the evils which flow from a want of it, as from that of the beneficial effects produced by its application. To the former of these points I shall principally address myself at this time, reserving the latter for another occasion, when the general application of Scientific Knowledge to the useful purposes of life will be taken into consideration.

There are some professions in which the necessity for a knowledge of the laws of Physics is so obvious, \* that it would seem almost superfluous to urge it. How, for instance, could either the Civil Engineer or the Architect expect to practice their respective professions with credit to themselves, or with advantage to the community, without a competent knowledge of the laws which govern motion and equilibrium, light, heat, &c.? It is true that the mere surveyor may learn by rote certain rules laid down for him by others, and may apply them to the purposes of measurement; and the builder may do the same in regard to constructive carpentry; but the Engineer and Architect, whose minds are liable to be drawn upon in all emergencies, must have them so stocked with sterling knowledge of principles, as to be able to meet the drafts upon them by the quick and certain application of such knowledge to the necessities of each case. It is impossible to form an opinion as to the extent to which a want of this knowledge has acted in retarding the improvement of our social

state. Thus, is it not painful to think how much time and capital have been uselessly expended in exploring the bowels of the earth for metals or fuel, where none could possibly have existed? Had the mining Engineers not merely observed the crust of the earth and followed its stratification, but also possessed a knowledge of the laws of chemical action, heat, &c., they would much sooner have generalised their observations, and have been enabled to conduct their operations on fixed and certain principles. Again, although canals have been for a great number of years in use amongst us, it has but lately been discovered that great speed may be obtained on them, with proportionably less injury to their banks by the action of waves, which, under such circumstances, is found to be almost entirely obviated. Railroads, too, have now been some years in use, and yet but little is known as to the proportion between speed and locomotive power. Even in the construction of forge chimneys in this town, an absence of the knowledge of the commonest truths is exhibited. There is more than one in which a great fissure may be perceived when the fire passes up it. The whole of the brickwork being tied and bound in together, and the inner part of it expanding more than the outer, on account of its greater proximity to the heat, a rent is made; in the same manner as a thick glass tumbler is broken by the sudden pouring of hot water into it. Is it not truly lamentable to behold some of the most beautiful buildings in the world prematurely crumbling into ruin, when the stupendous Druidical remains of Stonehenge prove that the country contains materials which can for ages withstand the assaults of the elements? Recently, however, Science has been brought to bear upon this subject, by the appointment of Commissioners to determine upon the quality of the stone to be employed in the construction of the Houses of Parliament, and their report is an extremely valuable document. It is because the want has been felt in these branches, and the work of improvement has commenced in good earnest, that I do not pursue the subject further, although it might be shewn that in a thousand ways the want of a competent knowledge of Physical Science by the Engineer and Architect will appear, and that in a thousand ways the possession of it will be productive of utility and advantage in the daily practice of their respective professions.

I pass on to the profession of the Law, in the practice of which

instances are daily occurring wherein a knowledge of Natural Philosophy proves most valuable, and wherein its absence might entail serious consequences. A case once occurred arising out of an accident on the turnpike road. A gentleman driving a gig was met by a stage coach; a collision took place, and he was thrown out of his gig with great violence. A question arose as to whom the blame was attributable. It was argued by the driver of the gig that the coach was proceeding at a furious rate, and he instances the distance at which he had been thrown as a proof of this. On the part of the coach proprietors it was proved that the gentleman was precipitated *a-head* of his gig, and then argued that the distance to which he was thrown was the exact measure of the velocity at which he was driving, and did not at all depend upon that of the coach. The gig being overturned and rendered stationary by coming in contact with the coach, a result which would have equally taken place had it struck against a post, the driver flew forward with the velocity at which he was before driving. The acquired velocity, multiplied by his weight, was the exact measure of the momentum with which he struck the ground. Just as when we urge a billiard ball along the table, we do not find it stop the moment we withdraw our hand from behind it; it moves on with a velocity proportioned to the momentum it had acquired at the time we ceased to urge it on, and it matters not to the velocity of the ball, whether our hand shall have been stopped by muscular exertion, or by coming in contact with a fixed obstacle. Such is one of the many cases which may come before a Court of Law, involving in them the principles of Natural Philosophy; and, inasmuch as the present advanced state of civilisation in this Country is mainly owing to the practical application of these principles, we may expect that every day they will become more involved and mixed up with those legal enquiries which increase in an almost geometric ratio with the advancement of society.

Nor is it less desirable that the Divine should make himself acquainted with Natural Philosophy. The unlettered peasant may read the book of nature to a certain extent, but how are its pages illuminated by the light of Science, what depth of thought does it not reveal, how does it clear the mind, and exalt our views of the Almighty Creator! I mean not a mere adeptness in mathematics

tical calculations, which, although it sharpens the intellect and strengthens the reasoning powers, does not enlarge the mind and touch the heart. The painter does not place his art in the mere handling of the pencil, in the painting of foliage, or in the figuring of drapery. True, he rejoices as he finds his dexterity in the use of his brush daily increasing, but it is only when he has employed it to embody and bring to light the visions of his mind, the creatures of his imagination, or the objects of his study in nature that he truly exults; and when by his last touches his figures are rounded into life, and made to swell out in relief from the canvass, when he has caused the mind to shine out through the countenance, then is he happy in the contemplation of his work, and he lives in the hope that others for ages to come, may read in it the workings of his own soul. Thus in applying mathematical calculations to unravel some of the Gordian knots which confine the truths of Science, we rejoice not so much in the skill with which we can unravel them (though there is a pleasure in this), as in the discovery of the previously hidden treasures which burst upon our view. The sublimity and wondrous contrivance they exhibit, give rise to a train of reflections which carries us beyond the present and which causes us to exclaim, in regard to things natural as well as those which are revealed, "Oh! the depth both of the knowledge and wisdom of God;" and the more we thus discover, the more irresistibly are we led to finish the sentence and say, "how unsearchable are His judgments, and His ways past finding out." Thus Natural Philosophy, while it exalts the character of the Almighty in our eyes, humbles us before Him. Sir John Herschel remarks, "The boundless views of intellectual and moral as well as material relations, which open on the Philosopher on all hands, in the course of these pursuits, the knowledge of the trivial place he occupies in the scale of Creation, and the sense continually pressed upon him of his own weakness and incapacity to suspend or modify the slightest movement in the vast machinery he sees in action around him, must effectually convince him, that humility of pretension, no less than confidence of hope, is what best becomes his character." This spirit of humility is the one of all others which should be anxiously sought by the Divine, both for himself and for those who look up to him for guidance and instruction. Somewhat of the same

feeling is excited in us, by perusing in the pages of history the actions of the mighty dead, and by viewing in our own and other countries, the works of living genius. While we acknowledge and feel their superiority, a longing desire comes over us to commune with such persons, and we should hail with infinite delight, any written communication from them, wherein we might read more of their mind, thoughts, and principles. Thus, too, when the wonders of the animal, vegetable, and mineral world open upon our view, an urgent desire is excited in our minds to receive a more direct communication from Him who ordereth all these things; and we turn with redoubled energy to the perusal of that sacred volume which contains a message from Him to each of us, which informs us of the relation in which we stand to Him, and of the manner in which He would have us regulate our conduct towards Himself and towards our fellow-creatures. Mr. Hare, in addressing the Students of Trinity College, Cambridge, thus beautifully expresses himself, "You have often been advised to study the Mosaic Law for the types of Christ contained in it. You have often been recommended to examine the history of the Jews for the matters typical of Christ contained in it. Let me exhort you to search also for like types in another book, a book penned by the same hand which guided the inspired penmen of the Bible, the book of God's Creation. So you will learn to look at Nature as you ought to look, to discern something more than the ever-changing colours and ever-waving folds of her garments, to catch sight of those capital features in which her spirit is most visibly expressed, nay, to pierce through her body to her soul, or rather to behold the workings of her soul in all the movements of her body. So will you learn to discover something more than the mere properties of space and time, lines and numbers, in her laws. So will you learn to breathe life into the dry bones of your Natural Philosophy. To the godly, holding converse with Nature is holding converse with God. It is to them as another and a prior Bible; which, when man's secondary writing has been rubbed off, and when the original characters are brought out and deciphered and rightly interpreted, as with the help of the other they may be, unites from all its regions and spheres in declaring the glory of God, and in shewing His handiwork. .... To what end indeed have we been endowed with

the creative faculty of the Imagination, which, glancing from heaven to earth, from earth to heaven, vivifies what to the eye seems lifeless, animates what to the eye seems torpid, combines and harmonises what to the eye seems broken and disjointed, and infuses a soul, with thought and feeling, with determinate purpose and submissive beneficence, into the multitudinous fantasmagoria of the senses? to what end, I ask, have we been so richly endowed? unless, as the prime object and appointed task of the Reason is to detect and apprehend the laws by which the Almighty Lawgiver upholds and rules the world he has created, it be in like manner the province and duty of the Imagination to be diligent in reading and studying the symbolical characters, wherewith God has engraven the revelations of His goodness on the interminable scroll of the visible universe. Both the one power and the other, when rightly employed, will be active and dutiful handmaids of Religion. They will enable us to recognise the traces of God's wisdom, of His goodness, and of His overruling providence, in all the objects around us, in the lowest, no less than in the highest. Thus to the truly pious mind all things become animated with a divine spirit. Whatever he sees is to him a memorial of God."\* It being, then, the tendency of the study of nature and her laws, to humble us and to raise the character of the Almighty, drawing our minds up to Him, and leading us to seek to know more and more of Him through His revealed Word, of how great value must it be to the Divine, whose holy office it is to direct the feelings of his flock to heaven, "himself to lead the way" in this pursuit.

A different opinion has been maintained by some, ever since the time when Physical Science began to rear its head in this country, and even in these days its study is sometimes denounced as having a tendency to lead the mind away from the God of Revelation, and to fix it in the hopelessness of Infidelity. Such persons incur a serious responsibility, by endeavouring to prevent men from employing the faculties, with which their Maker has endowed them, in examining His works and in unravelling the laws by which it has pleased Him to regulate the Universe. Were this fear entertained by men who had themselves thoroughly investigated the truths of Science, and had experienced injurious effects upon their own minds, it would

\* Sermons by the Rev. J. C. Hare, M. A., page 222.

indeed be a startling objection. But in vain we search for Natural Philosophers among the objectors to Physical Science, whose opinions are grounded on the observation of such effects on some others, and the fancied discrepancies between the discoveries of Science and the Word of God; while the most successful scientific enquirers have been in the number of those who have been distinguished alike for the nobleness of their sentiments and their pure and heart-felt piety. The fact is, that the name of Science, like that of the sacred love of liberty, is often assumed by men whose looseness of principle and immorality of conduct, has rendered them anxious to cheat their own consciences, and to pull down others to their own base level, striving to pollute the atmosphere of society in general with the same effluvia as that which floats around themselves; while the knowledge of the phenomena of Nature, on which they dare to question the authority of Revelation, is confined to that spurious "science falsely so called," which is sufficient to fill them with the arrogance of pretension, but cannot produce that humility which results from an accurate knowledge of the present state of any one branch of Natural Philosophy. There is, indeed, nothing pure or holy which may not be perverted to such vile purposes; but the great error seems to consist in mistaking the *pretext* for the *cause* of the evil. Rather than thus inveigh against these illegitimate uses of Scientific Knowledge, let us encourage its diffusion so widely, that it can no longer be made the mask under which the vicious and profane shall be able to act their hypocritical parts without the certainty of speedy detection. A *partial* knowledge might lead men to suppose that some of the discoveries of Science were at variance with the Word of God; but, when all its bearings and truths are thoroughly understood, it is found that the facts of both are in strict accordance with, and mutually confirmatory of each other; and if its study do not lead the mind to the God of Nature, and thence to the God of Revelation, then indeed must the fault lie in the constitution of that mind, and in its awful determination to choose "darkness rather than light, because its deeds are evil."

I now come to the profession of Medicine, the duty of the members of which is to preserve as long as possible the health and vigour of

the human frame, which, although under the influence of the vital principle, as well as the direction of a superior intelligence, is essentially a machine, the parts of which are all put together, and perform their various functions, according to the laws of Physics. Hence the importance of these laws being thoroughly understood by the medical practitioner. It is difficult to estimate how much the progress both of Astronomy and Medicine was retarded by the prevalence of the opinions of Aristotle and his followers, who supposed that the heavenly bodies and the animal frame were governed by laws peculiar to themselves, and distinct, as well from each other, as from those which affected the inanimate matter of the earth. Aretæus, one of the most accurate observers, whose descriptions of the signs of disease were singularly clear and graphic, has fallen into some of the most absurd notions that have ever offended against the common sense of mankind. Thus, in endeavouring to account for the uncertain and ever-varying forms of Hysteria, he supposes the organ affected to be a living creature which moves about from one part to another, and shifts continually the locality of the disease. Even in days much nearer our own, when Anatomy assumed the rank of a Science, and the separate parts of the human body were examined with care at the point of the scalpel, how many absurd theories appeared only to be succeeded by others equally ridiculous! And I think I shall be able to shew that the received opinions of the present day concerning the causes of some of the sounds heard in the human chest are diametrically opposed to the laws of Physics. Surely these errors could not have existed, had they who fell into them been acquainted with those laws.

It has been contended that the study of natural and pathological Anatomy will suffice to point out the nature of disease, inasmuch as the maker of a machine can soon discover and rectify any derangements in its movements. But the cases are not similar. The mechanist can unmask and lay bare every part of his machine while in motion, which is far from being the case as regards the human body. The first indications of any derangement of its internal parts are furnished by irregularity in the functions they are destined to perform; and before this can be detected, the manner in which these functions are performed during health, must

be perfectly understood. Hence arises the study of Physiology, in which so many various matters enter, and in every part of which the laws of Physics and Chemistry are concerned. For there are in the human body joints of all kinds, levers, and pulleys; there are forces acting in all directions; there are fluids in motion, and a pneumatic apparatus constantly at work; there are arches and cylinders, pillars, and tubes. It contains the most perfect optical instrument in the world, the eye, which receives every species of impression conveyed by light, and through the medium of which the mind judges of every shade of colour, of dimension, and of distance. This body is often placed in a very variable climate, wherein the alternations of cold and heat are frequently occurring; and hence attention must be paid to habits, clothing, lodging, ventilation, &c., with a view to the preservation of that degree of heat which is best suited to the purposes of life generally, and the health of individuals particularly; and hence an acquaintance with the laws of heat, electricity, &c., is required. It may be considered, too, as a laboratory in which the most varied and numerous chemical operations are constantly going on. The study of Chemistry is now, I admit, encouraged and enforced; still students are too apt to limit their views of Chemistry to its effect upon the compounding and mixing of drugs; and the time is hardly passed away when the talent and skill of the Physician would have been estimated by many, in proportion to the chemical knowledge he displayed in grouping together different medicines in his prescriptions. But in truth the compounding of drugs is the smallest branch of those subjects to the proper understanding of which a knowledge of Chemistry is absolutely necessary. By Chemistry, in conjunction with Anatomy, is obtained a knowledge of the phenomena of digestion and assimilation. In the hands of Professors Tiedeman and Gmelin, it has been made to remove the veil with which these functions were so long covered, and to lay bare some of the inward workings of the body with the most wondrous precision and clearness. It is thus, and thus alone, that the true office of the liver has been ascertained, and proved to be subsidiary to that of the lungs; the former separating from the blood the excess of carbon and hydrogen in the shape of bile, which is not sufficiently carried off by the act of respiration as aqueous vapour and carbonic acid

gas. As regards the subject which is about to engage our attention in these Lectures, who can understand the physiology of respiration, without an acquaintance with the laws of equilibrium and motion, as applied both to solid and gaseous bodies? Who, that of circulation without knowing somewhat of the laws which govern liquids, both in a state of rest and motion? Even in this small field of our enquiry then, a knowledge of Pneumatics, Statics, Dynamics, Hydraulics and Hydrostatics is required. Who, again, would endeavour to reason upon the causes which tend to produce and modify the various sounds heard within the human chest, unless he knew something of Acoustics? And not only is a knowledge of Natural Philosophy required in the study of the healthy action of the parts which compose the human body, but it is of practical application in the discovery of disease, numerous instances of which will appear in this Course.

It may be said that for practical purposes the knowledge of Natural Philosophy is not required; because its application to each subject may be laid down in rules which can be easily acquired. To learn a profession thus by rules, of the formation of which we know nothing, is, to say the least, a very unsatisfactory mode of proceeding; and could only be recommended, I presume, under the idea that a saving of time would be effected: even on this ground, however, it cannot be defended, for the difficulty of remembering these rules is such, that they are constantly escaping the memory, till they are at length beaten into us by practice; and when lost, we have no clue to bring them back: in the same way as the Anatomy of books leaves us almost as soon as we have learnt it, while that which we have acquired by dissection is recalled to our recollection by a thousand remembrances of time and place. When a law of Natural Philosophy, however, is thoroughly understood and mastered by following its induction from experiment, it is acquired for ever; and although the rule of its application may escape us for a moment, yet the principle is the clue which speedily leads us right. Again, by studying a profession in the superficial way here alluded to, the utmost we can hope for is, to do as well as others have done before us. We cannot expect to advance the science of our profession, and to bear our part in detecting error and discovering new truths; for we should be crippled at every turn by our ignorance of first principles, and although our facts might be

accurately observed, our deductions from them might be hollow and unsound. The operative watch-maker may repair a watch, but he could not hope to make any grand discovery whereby its action could be improved, unless he knew the principles on which it was constructed ; he might make compensation balance wheels, but he could hardly be expected to improve upon them unless he understood the principle upon which the compensation took place. Would you wish to be thus fettered and cramped ? Have you never experienced an earnest desire to advance your profession ? Have you never, when at times a suspicion of the unsoundness of this or the other opinion crossed your minds, have you never longed for the time when you might solve the doubt ? When you have observed a want of knowledge in this or the other branch of your studies, have you never thirsted to discover the true spring ? I ask, not whether you have sighed for applause, or wished that you had discovered some of the grand truths which have at different periods reflected glory on their discoverers ; this feeling, the offspring of vanity, though more especially cherished by little minds, is more or less common to all ; but I ask whether you have not often wished that the boundaries of the science of your respective professions should be enlarged, and determined that you would one day devote yourselves with zeal and energy to this great work ? If so, you will begin by laying your foundation in a sound and thorough knowledge of the laws of Nature, as developed in the Universe around you : for this alone will give a proper direction and stability to your researches. To a mind, which however well-stored with general information and learning has no solid foundation of first principles, there is a constant feeling of restlessness and uneasiness, an infirmity of purpose, and a strange mixture of thoughts and projects ; there is an unwillingness to enter upon any great field of enquiry or labour, from the consciousness that it is almost useless to be adding to a superstructure, the base of which is known and felt to be defective.

After all, it may be said that a course of such study would occupy more time than could be devoted to it by students. There would be some force in this objection were it necessary to go through a complete train of mathematical investigation ; because this would require three or four years of unremitting and uninterrupted application. Happily this is unnecessary ; for a very short time will suffice

to acquire such simple rules of arithmetic and elementary mathematics as shall enable us to comprehend the leading truths of Physical Science. On this subject the authority of Sir John Herschel is conclusive:— “There is scarcely any person,” he remarks, “of good ordinary understanding, however little exercised in abstract enquiries, who may not be readily made to comprehend at least the general train of reasoning by which any of the great truths of Physics are deduced, and the essential bearings and connections of the several parts of Natural Philosophy. There are whole branches too, and very extensive and important ones, to which mathematical reasoning has never been at all applied; such as Chemistry, Geology, and Natural History in general, and many others in which it plays a very subordinate part, and of which the essential principles, and the grounds of application to useful purposes, may be perfectly well understood by a student who possesses no more mathematical knowledge than the rules of arithmetic; so that no one need be deterred from the acquisition of knowledge, or even from active original research in such subjects, by a want of mathematical information. Even in those branches which, like Astronomy, Optics, and Dynamics, are almost exclusively under the dominion of mathematics, and in which no effectual progress can be made without *some* acquaintance with geometry, the principal *results* may be perfectly understood without it.”\*

Enough has, I think, now been said to prove the direct advantages arising out of a study of Natural Philosophy by the student who desires to become thoroughly acquainted with the theory and practice of his profession, and to devote himself to original research; but there are some indirect advantages also to which I am anxious to call your attention.

In the present day most persons of education know something of Natural Philosophy, and often form their opinion of a professional man from the degree of knowledge they find him possessed of on those points wherein their own information enables them to judge. They know that such knowledge is requisite for the proper study of a liberal profession; should they, therefore, find him deficient in the ground work, they will necessarily be led to suspect the quality of the super-structure; but should they, on the other hand, find him possessed of

\* Discourse on the Study of Natural Philosophy, page 25.

a competent knowledge of those branches with which they themselves are familiar, they will be inclined to give him credit for the possession of professional knowledge of an equally sound and sterling quality. They would not go so far as to imagine that, because he was well-skilled in Natural Philosophy, he must, on that account, necessarily be a good Engineer, Lawyer, or Physician ; but they would certainly argue that he could not be such, without a competent knowledge of the important subjects which it embraces. They may possess other means of ascertaining the powers of his mind and his habits of application, but they are naturally anxious to know whether these have been employed by him in the practical duties of his profession ; and, as they can know nothing of these, they can only test this point on the neutral ground of Science which is common to him and them. And surely to be considered in the possession of Scientific Knowledge which you are daily in the habit of applying to the purposes of your profession, is no small step towards professional eminence. In short, the absence of scientific knowledge will sooner or later be detected, and injury to your prospects will result from such discovery ; while its presence will some day be perceived, and your character rise in proportion.

Again, by acquiring this knowledge during your pupilage, you will not only be better qualified to profit by the Lectures and instruction of those experienced teachers under whom you will be placed in the Metropolis, but you will be enabled, on engaging in the practice of your respective professions, at once to take a part in the diffusion of Scientific Knowledge, and will thus become useful members of the society among whom you are thrown, and will be employing a most legitimate and proper method of making yourselves known to, and respected by, the most influential and intelligent classes.

I am well aware that very different advice will be sometimes tendered to you, even by those who have your interest at heart, under a belief that a character for scientific attainment will not, in the slightest degree, contribute to your professional advancement ; and although they may not be desirous of restraining you from the study of Science during your pupilage, they will recommend you, when once you have entered on the practical duties of your profession; to devote all the time that remains, after these shall have been carefully performed, to the cultivation of the ac-

quaintance and patronage of such persons as may be likely to advance your interests in life. A little reflection will convince you that the tendency of such advice is ruinous. The line of conduct it recommends may succeed for a time, but it lays no solid foundation for a career which shall lead to eminence, and shall be dwelt upon with satisfaction by yourselves. It must be owned that some persons, eminently skilled in Science and Literature, both general and professional, have failed of success in practice; but this will be found to have arisen, in a great majority of cases, from certain deficiencies, either of manner or exertion, which none can afford to overlook. On the other hand, instances of pecuniary success, independent and irrespective of the slightest scientific acquirement, may be adduced. Such cases, happily, form the exception rather than the rule, and must necessarily occur in a Country where, after a profession is once entered upon, there is no further direct competition in which the prize is awarded to talent and learning; but where all is left to be decided by public opinion when the majority of persons are ignorant of those principles on a knowledge of which alone a sound opinion can be formed. I would not be supposed for a moment to underrate the advantages of urbanity of manner, and of careful forethought; but I maintain that to take a high standing in any profession, we must exhibit disinterestedness of character, candour of disposition, and generosity of sentiment; and must devote ourselves with ardour to the cultivation of those branches of Science which bear upon that profession, labouring daily in applying them to the elucidation of truth and the increase of sound and useful knowledge. And if we even go a step beyond this, and devote some small portion of our time to classical and literary pursuits, I have yet to learn, nor will I believe, that the Philosopher and the Scholar is less likely to meet with his reward than the person who would devote all his attention to forward his pecuniary prospects.

Although public facilities for acquiring Scientific Knowledge are, as yet, very limited, much may be learnt by Students who will assemble themselves together in small parties. In studying Mechanics, they may construct or procure small pieces of machinery which will illustrate the mechanical powers, the laws of equilibrium, gravity, &c. In Hydraulics, they can easily experiment on the motion and pressure

of fluids. Even in Chemistry much may be done at a very small cost. A medical student of this town who has a strong taste for Chemistry, and to whom I was indebted for much valuable assistance when engaged in my late Course of Lectures on that subject, having constructed his own machinery and apparatus, succeeded in making himself a thoroughly good and practical Chemist; and as a proof that these pursuits did not interfere with his other duties, I may mention that he has this year carried off the first prize in almost every department of medicine, at King's College, London.\* There are, certainly, some branches of Experimental Philosophy in which costly apparatus is required. Such is usually to be found at the philosophical institutions of large towns, amongst whose members are often gentlemen of considerable scientific attainments, who would feel a pleasure in explaining the points which such apparatus is designed to illustrate. When thus associated together for the purpose of mutual improvement, you can hardly fail to meet with assistance and encouragement; and by devoting to philosophical enquiries those hours which too many spend in frivolous or vicious pursuits, you will be preserved from evil, and will be laying the foundation of future success and honourable distinction. So much for the student.

But it is no less necessary for those who are embarked in the practice of a profession to continue their studies in Natural Philosophy, or, if they have been neglected in early life, to commence them with vigour at a later period. When the mind and body are alike fatigued by arduous duties, how refreshing is it to turn to Experimental Philosophy, which affords a wholesome relaxation, at the same time that its successful cultivation renders us more fitted to advance the science of our respective professions!

It has been insinuated, that pure literary and scientific research is incompatible with the proper discharge of the practical duties of a profession, by intrenching on the time which should be devoted to them. If the greater part of our time were thus employed, there might be some truth in this; but happily, a very small portion of it regularly devoted to this object will enable us to keep up a moderate acquaintance with Literature and Science; and it must be remembered that some change of occupation is absolutely

\* Mr. William Miller, since elected Chemical Demonstrator at King's College.

necessary to the mind. Is it not often found that the most distinguished authors have been among the most successful professional practitioners? Was Bacon less fitted to preside over a Court of Equity, because he was the father of inductive philosophy? or Sir Philip Sydney to command the armies, and assist at the councils of his Sovereign, because he was a sound and elegant scholar? Was Dr. Wells less calculated to investigate and treat disease with success, because he so beautifully discovered and worked out the theory of the dew? Was Bishop Watson rendered a less efficient vindicator of the Bible by being an accomplished Chemist? or did Charles Wolfe labour less devotedly among his parishioners in the north of Ireland, and was he less often found at the bed-side of poverty and sickness, spending himself in the service of his Divine Master, because he had cultivated his poetic genius, and had consecrated his talents to embalm the memory of one of England's greatest generals, in verses the most truly pathetic that have been produced in our language? It would not be difficult to show that some of the best contributions to Literature and Science in our own day have been furnished by gentlemen distinguished for the talent, industry, and zeal with which they discharge the duties of their respective professions, and in which they occupy most prominent positions. The study of Physical Science, so far from interfering with the practical duties of any profession, renders men more fitted to their task. Constantly habituated to trace the connection between cause and effect, and to deduce general laws from the observation of phenomena and of experiments, admitting no generalisations but such as are grounded on facts most faithfully and accurately observed, our minds become eminently practical, and we are enabled to draw sound and useful conclusions from the circumstances which daily present themselves to our view, with a clearness, rapidity, and precision, which are almost mistaken for intuition by a superficial observer, but which, in truth, are the natural accompaniments of a well-disciplined mind.

We are not only thus prepared for active duty, but our minds are enlarged and our hearts are improved; for who can contemplate the workings of Nature, and trace her unerring laws, without feeling an enlargement of mind, and increased benevolence of disposition? We are thus guarded from degenerating into heedlessness

and apathy, or from becoming narrow-minded and prejudiced; we are enabled to measure our own position with accuracy, and to take those comprehensive and philosophical views of our professional pursuits which alone can lead to any great and useful discoveries. Our hearts, too, are purified from those hateful feelings of envy and jealousy which are so apt to creep in; we cease to regard one another as contending rivals, but rather as fellow-workmen in one great cause, stimulating each other to active research by mutual encouragement and the interchange of observations bearing upon the subjects of our respective enquiries. We are thus led to use our utmost endeavours to prevent dissensions among our brethren, to heal the wounds which the thoughtless and cruel may have inflicted, to cheer up the despairing, and to bind all together in one solid and united body. While, however, we would, as much as possible, throw a veil over the failings and errors of others, we are not led into a hurtful extreme; but should we perceive dishonourable conduct, whether against, or on the part of any of our body, and should remonstrance fail, we should not hesitate boldly and openly to mark our sense of disapprobation, and thus uphold the dignity of our profession and our character.

By thus employing our leisure hours our minds are preserved in that calm and even state which is so essential to the proper discharge of our duties; neither dissipated by frivolous amusement, nor agitated by the excitement of political zeal. And if, as I have stated, the transition be easy from Natural to Revealed Religion; if, by a study of the former, which can hardly be separated from that of Natural Philosophy, the attention shall be more frequently turned to the latter, of how great value will our studies prove to us! for, to say nothing of the value of religion to us as individuals, there is no class of men on whom its influence is attended with more benefit to society at large, than the members of the professions of Medicine and Law. Sometimes they are placed in situations of such extreme delicacy, that the least wavering of principle would plunge whole families into the deepest sorrow. What better guarantee, then, can be offered for the maintenance of good principle, when that maintenance is of such value, than its religious foundation? It is the duty of the Physician, moreover, to watch the decay of the body, the gradual giving way

and final rupture of the tie that binds the spirit to earth; and although it be the especial province of the Divine to prepare it for its flight, yet are there times when the Physician can speak the words of caution or of comfort, when he may recall the thoughtless to a consideration of their state, and may raise the drooping spirit which is bowed down by bodily suffering.

We have now seen the importance of the study of Natural Philosophy to Engineers and Architects, and to the members of the professions of Divinity, Law, and Medicine; but I must go a step further, and affirm its importance to *all* members of society.

To what does this country owe its present place in the scale of nations, and its advanced state of civilisation, but to the discoveries which have, at successive periods, been made in Natural Philosophy? the practical application of which to the useful purposes of life (as instanced in the steam engine) has brought our peculiar resources into use, and has made us wealthy and powerful. Now have we attained the summit of the scale, or may we not expect to rise higher and higher by the same means? There is nothing in the history of past nations that should lead us to limit our expectations in these respects. The canker of slavery no longer preys upon our vitals from within, as it did in the palmy days of the ancient republics; nor are there any savages to pour in upon us from without, and extinguish our arts and sciences. What, then, shall stay our progress? Shall not each newly discovered spring of Scientific Knowledge be speedily turned into an useful channel, and swell the tide of civilisation which shall eventually sweep before it every obstruction raised by ignorance, and shall irrigate and enrich our Country? I do not mean to say that it shall flow in an uniform and uninterrupted stream; because while it is pursuing its course, and receiving force and magnitude from each tributary that joins it, there will necessarily be some back currents. Thus, we frequently see trade and prosperity transferred from some places in this Country to others, by improvements effected in the means of internal communication, as they were formerly in Europe by that of navigation. The time was when the treasures of the East were poured into the lap of Venice, when she sat as a swan upon the waters, rejoicing in the sun of her prosperity; but long since her proud bearing has departed; for a while she chaunted the death-note of her

expiring commerce ; and now she lies lifeless upon the waters, and is peopled only in imagination by the merchant princes of her former days. Obstacles, too, will oppose themselves to the career of civilisation, just as when the advancing waves of a stream are forcing a new channel before them, and pouring in upon a mass of matter hitherto compact, and dry. Ere it has been altogether broken up, huge fragments will be detached and thrown about with frightful violence and these at times uniting with each other will oppose a barrier to the advancing tide, threatening to turn it from its course, to deal destruction on all sides. But the more broadly they are opposed to the stream the sooner will they become moistened, and the longer they hold together the more complete will be their downfall when at length the accumulated force of the waters breaks them up, and crumbles them into a pulpy mire. Thus we see the progress of improvement interrupted, and society convulsed by restless agitators, who unite with each other to turn the course of knowledge from its proper direction, and to apply it to the levelling of the distinctions which have been raised by industry and talent, and to the disturbance of social happiness and order. Still, in spite of these obstacles and back currents, every year finds us more advanced, more wealthy, more powerful, better informed, and, I would fain hope, better conducted. When we see, too, that the truths of religion become extended in proportion to the increase of general knowledge ; that our ships carry with them to distant lands not only the produce of our industry, but the book of our faith and the expounders of its doctrines, we may surely hope that our advancement is of that good and solid kind that shall not be materially checked ; but that, while the increase of our Scientific Knowledge shall ensure our faith from the pollution of gross error and absurdities, and facilitate its diffusion both at home and abroad ; it shall in its turn, as it always has done, exert a direct and beneficial influence upon our prosperity and happiness.

Since, then, society has of late progressed, and may be expected to progress still further by the cultivation and application of Natural Philosophy, does it not become a self-evident proposition, that a knowledge of its principles is essential to a well-educated man ? We study the pages of history, and we endeavour to make ourselves

acquainted with the causes which have tended to the rise and fall of empires, and which have advanced or retarded the social condition of mankind ; we direct our attention to the language, habits, and geographical position of various nations, and endeavour to trace the effects of different systems of legislation ; and all with the avowed object of gaining experience from the past, that we may apply it to improve the state of society in our own generation. In this, doubtless, we do well ; but are we not bound to go on still further, and to make ourselves acquainted with those principles of Science which under our very eyes are working such wondrous changes in our position ? If we do not thus, we are like men shut up in a valley surrounded by inaccessible rocks ; we live on from one day to another, neither bearing our part in the great work that is going on, nor knowing how others are carrying it on. Ignorant of the principles on which the improvement of our social state is taking place, we can neither assist in practically working it out among our neighbours, nor can we appreciate the labours of others in this cause. Borne to foreign countries, we are not in a situation to explore their natural products or to calculate their resources ; and when we return home we can have but little information to impart, which will prove of the least value in bettering the condition of our countrymen.

In short, living as we do in an age and in a country wherein the application of Scientific Knowledge is the grand source of power, of wealth, and, to a certain extent, of happiness, we are called upon to go in advance of its stream which is so nobly rolling onwards, to clear away the obstacles which oppose themselves to its progress, and to facilitate its course through such channels as shall lead to the permanent welfare of mankind.

After all, perhaps, the most powerful motive for the cultivation of Physical Science is derived from the generous sentiments with which it inspires us. When we review our past feelings and actions, we often find that it is difficult to determine whether pleasure or pain has most predominated in the exercise of our intellectual powers ; that our best efforts have sometimes been directed to unworthy objects ; that when we have most deserved success it has been denied us, or that, when attained, its pleasure has fallen far short of our anticipations. But when all else fails, the improvement of the heart will

remain, and the consciousness of it yield an abiding and solid satisfaction. The time may come when the mind itself shall totter, when the imagination can no longer pierce the ideal world, when the reasoning faculties shall refuse their office, and memory shall be unable to use the accustomed key-words to unlock the trains of thought which they were intended to re-open. Amidst this melancholy decay of the mental faculties, and when the scientific acquirements of a long life are one by one departing, generosity of sentiment, their true and legitimate offspring, shall still remain; and being connected with a sure trust in Him whose works were the great objects of study and admiration shall hallow the latter days of the Natural Philosopher.

Let us remember, however, that the great improvement of the heart, its purification from self-love, is not a necessary consequence of having our *understandings* enlightened by the truths of Natural or even Revealed Religion. This can only be accomplished by the subjection of our *will* to that of our Maker. By this means alone shall we be enabled to exercise that self-denial and self-devotion from which are derived all the noble actions of the great and good. And we shall have our reward. "He who seeks after love in the spirit of self-sacrifice, will win love. He who seeks after glory in the spirit of self-sacrifice, will win glory. He who seeks after truth in the spirit of self-sacrifice, will win truth. At the same time he will have obtained a privileged immunity from all those anxieties and distractions and fears, from all those vain hopes and gnawing desires, and enlarking jealousies and rancorous animosities, and from that undying worm of envy, of which selfishness is the sole and prolific parent. Misfortune cannot befall him. Evil cannot touch him. Death cannot harm him. He has already passed through the gates of immortality."\*

\* Sermons by the Rev. J. C. Hare, page 275.

# A D D R E S S

EXR

DELIVERED AT

THE SOUTHAMPTON MEETING

OF

THE BRITISH ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE,

SEPTEMBER 10, 1846,

BY

SIR RODERICK IMPEY MURCHISON, G.C. ST.S.,  
F.R.S., V.P.G.S. & R. Geogr. S.,

MEM. IMP. ACAD. SC. OF ST. PETERSBURGH, CORR. MEM. ROY. INST. SC. PARIS, ETC.,

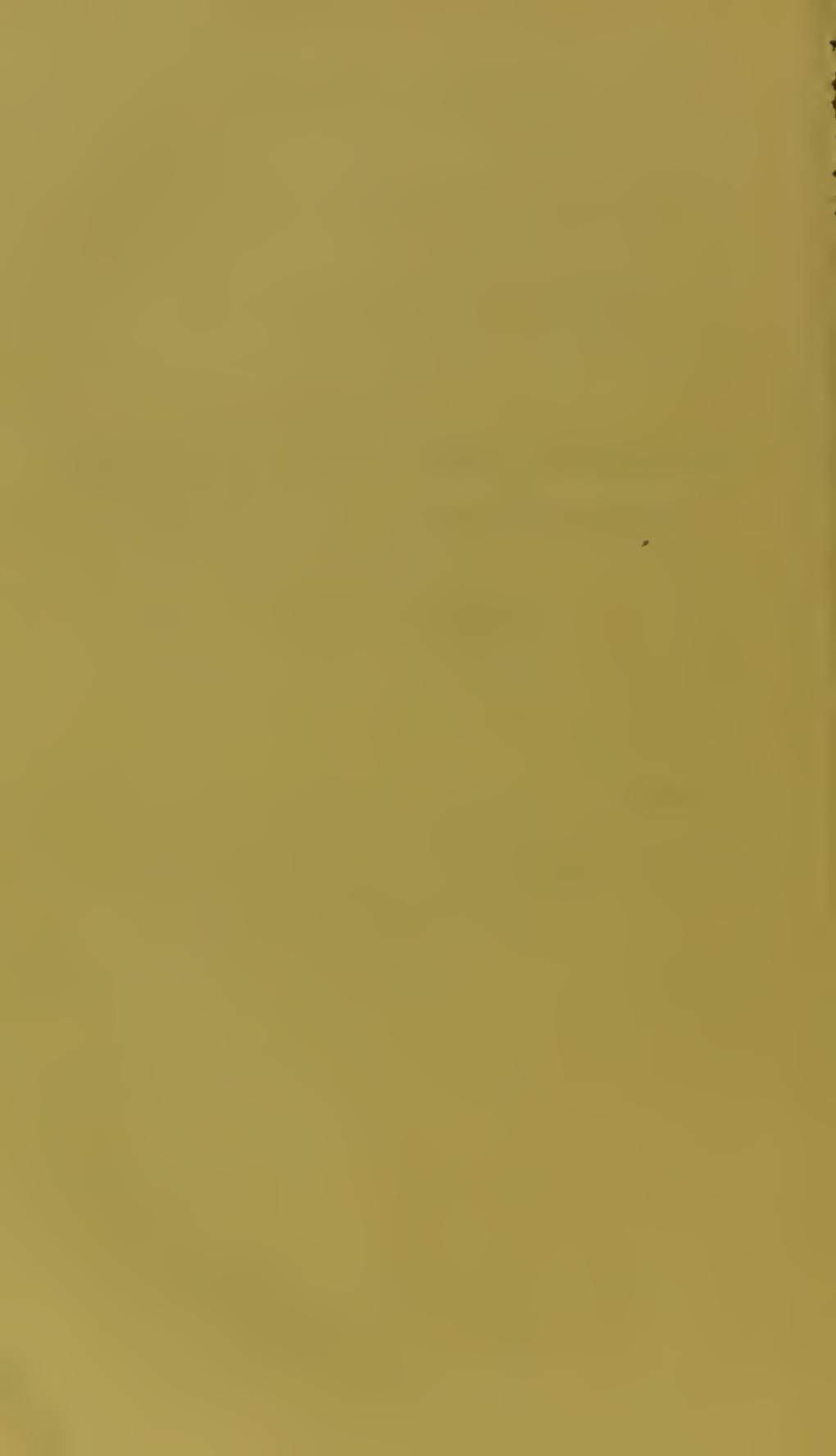
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1846.



# A D D R E S S

BY

SIR RODERICK IMPEY MURCHISON, G.C.ST.S., F.R.S., V.P.G.S.  
&c. &c.

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GENTLEMEN,

AFTER fifteen years of migration to various important cities and towns in the United Kingdom, you are for the first time assembled in the South-Eastern districts of England, at the solicitation of the authorities and inhabitants of Southampton. Easily accessible on all sides to the cultivators of science, this beautiful and flourishing sea-port is situated in a tract so richly adorned by nature, so full of objects for scientific contemplation, that, supported as we are by new friends in England, and by old friends from distant parts of Europe, we shall indeed be wanting to ourselves, if our proceedings on this occasion should not sustain the high character which the British Association has hitherto maintained.

For my own part, though deeply conscious of my inferiority to my eminent predecessor in the higher branches of science, I still venture to hope, that the devotion I have manifested to this Association from its origin to the present day, may be viewed by you as a guarantee for the zealous execution of my duties. Permit me then, Gentlemen, to offer you my warmest acknowledgements for having placed me in this enviable position; and to assure you, that I value the approbation which it implies as the highest honour which could have been bestowed on me—an honour the more esteemed from its being conferred in a county endeared to me by family connexions, and in which I rejoice to have made my first essay as a geologist.

The origin, progress and objects of this our "Parliament of Science" have been so thoroughly explained on former occasions by your successive Presidents, particularly in reference to that portion of our body which cultivates the mathematical, chemical and mechanical sciences, that after briefly alluding to some of the chief results of bygone years, with a view of impressing upon our new members the general advances we have made, I shall in this address dwell more particularly on the recent progress and present state of natural history, the department of knowledge with which my own pursuits have been most connected, whilst I shall also incidentally advert to some of the proceedings which are likely to occupy our attention during this Meeting.

No sooner, Gentlemen, had this Association fully established its character as a legitimate representative of the science of the United Kingdom, and by

its published Reports, the researches which it instituted, and the other substantial services which it rendered to science, had secured public respect, than it proceeded towards the fulfilment of the last of the great objects which a Brewster and a Harcourt contemplated at its foundation, by inviting the attention of the Government to important national points of scientific interest. At the fourth Meeting held in Edinburgh, the Association memorialized the Government to increase the forces of the Ordnance Geographical Survey of Britain, and to extend speedily to Scotland the benefits which had been already applied by that admirable establishment to the South of England, Wales and Ireland. From that time to the present it has not scrupled to call the notice of the Ministers of the day to every great scientific measure which seemed, after due consideration, likely to promote the interests or raise the character of the British nation. Guided in the choice of these applications by a committee selected from among its members, it has sedulously avoided the presentation of any request which did not rest on a rational basis, and our rulers, far from resisting such appeals, have uniformly and cordially acquiesced in them. Thus it was when, after paying large sums from our own funds for the reduction of masses of astronomical observations, we represented to the Government the necessity of enabling the Astronomer Royal to perform the same work on the observations of his predecessors which had accumulated in the archives of Greenwich, our appeal was answered by arrangements for completing so important a public object at the public expense. Thus it was, when contemplating the vast accession to pure science as well as to useful maritime knowledge, to be gained by the exploration of the South Polar regions, that we gave the first impulse to that project of the great Antarctic expedition, which, supported by the influence of the Royal Society and its noble President, obtained the full assent of the Government, and led to results which, through the merits of Sir James Ross and his companions, have shed a bright lustre on our country, by copious additions to geography and natural history, and by affording numerous data for the development of the laws that regulate the magnetism of the earth.

The mention of terrestrial magnetism brings with it a crowd of recollections honourable to the British Association, from the perspicuous manner in which every portion of fresh knowledge on this important subject has been stored up in our volumes, with a view to generalization, by Colonel Sabine and others; whilst a wide field for its diffusion and combination has been secured by the congress held at our last meeting, at which some of the most distinguished foreign and British magneticians were assembled under the presidency of Sir John Herschel.

It is indeed most satisfactory for us to know, that not only did all the

recommendations of the Association on this subject which were presented to our Government meet with a most favourable reception, but that in consequence of the representations made by Her Majesty's Secretary of State for Foreign Affairs to the public authorities of other countries which had previously taken part in the system of cooperative observation, the Governments of Russia, Austria, Prussia and Belgium have notified their intention of continuing their respective magnetical and meteorological observations for another term of three years.

In passing by other instances in which public liberality has been directed to channels of knowledge which required opening out, I must not omit to notice the grant obtained from our gracious Sovereign, of the Royal Observatory at Kew, which, previously dismantled of its astronomical instruments, has, under the suggestions of Professor Wheatstone, been converted by us into a station for observations purely physical, and especially for those details of atmospheric phenomena which are so minute and numerous, and require such unremitting attention, that they imperiously call for separate establishments. In realizing this principle, we can now refer British and foreign philosophers to our own observatory at Kew, where I have the authority of most adequate judges for saying they will find that a great amount of electrical and meteorological observation has been made, and a systematic inquiry into the intricate subject of atmospheric electricity carried out by Mr. Ronalds, to which no higher praise can be given, than that it has, in fact, furnished the model of the processes conducted at the Royal Observatory of Greenwich. This establishment is besides so useful through the facilities which it offers for researches into the working of self-registering instruments which are there constructed, that I earnestly hope it may be sustained as heretofore by annual grants from our funds, particularly as it is accomplishing considerable results at very small cost.

Our volume for the last year contains several communications on physical subjects from eminent foreign cultivators of science, whom we have the pleasure of reckoning amongst our corresponding members, and whose communications, according to the usage of the Association, have been printed entire amongst the reports. In a discussion of the peculiarities by which the great comet of 1843 was distinguished, Dr. Von Boguslawski of Breslau has taken the occasion to announce the probability, resting on calculations which will be published in Schumacher's 'Astronomische Nachrichten,' of the identity of this comet with several of a similar remarkable character recorded in history, commencing with the one described by Aristotle, which appeared in the year 371 before our era: should his calculations be considered to establish this fact, Dr. Von Boguslawski proposes that the comet should hereafter be distinguished by the name of "Aristotle's Comet." This communication

contains also some highly ingenious and important considerations relating to the physical causes of the phenomena of the tails of comets.

Dr. Paul Erman of Berlin, father of the adventurous geographical explorer and magnetician who was one of the active members of the magnetic congress at Cambridge, has communicated through his son some interesting experiments on the electro-dynamical effects of the friction of conducting substances, and has pointed out the differences between these and normal thermo-electric effects. Baron von Sennfenberg (who is an admirable example of how much may be done by a liberal zeal for science combined with an independent fortune) has published an account of the success with which self-registering meteorological instruments have been established at his observatory at Scutenburg, as well as at the national observatory at Prague.

Of our own members, Mr. Birt has contributed a second report on Atmospheric Waves, in continuation of the investigation which originated in the discussion by Sir John Herschel, of the meteorological observations which, at his suggestion, were made in various parts of the globe, at the periods of the equinoxes and solstices, commencing with the year 1834.

In a communication to the Meeting of the Association at York, Colonel Sabine treated with great clearness (from the hourly observations at Toronto) the effect of the single diurnal and single annual progressions of temperature, in producing on the mixed vapours and gaseous elements of the atmosphere, the well-known progressions of daily and yearly barometrical pressure. To the conclusions which he then presented, and which apply, perhaps generally, to situations not greatly elevated in the interior of large tracts of land, the same author has added, in the last volume, a valuable explanation of the more complicated phenomena which happen at points where land and sea breezes, flowing with regularity, modify periodically and locally the constitution and pressure of the atmosphere. Taking for his data the two-hourly observations executed at the observatory of Bombay by Dr. Buist, Colonel Sabine has succeeded in demonstrating for this locality *a double daily progression of gaseous pressure*, in accordance with the flow and re-flow of the air from surfaces of land and water which are unequally affected by heat. And thus the diurnal variation of the daily pressure at a point within the tropics, and on the margin of the sea, is explained by the same reasoning which was suggested by facts observed in the interior of the vast continent of North America.

Among the many useful national objects which have been promoted by the physical researches of the British Association, there is one which calls for marked notice at this time, in the proposal of Mr. Robert Stephenson to carry an iron tube or suspended tunnel over the Menai Straits to sustain the great railway to Holyhead. This bold proposal could never have been

realized, if that eminent engineer had not been acquainted with the great progress recently made in the knowledge of the strength of materials, and specially of iron ; such knowledge being in great measure due to investigations in which the Association has taken and is still taking a conspicuous share, by the devotion of its friends and the employment of its influence—investigations which have been prosecuted with great zeal and success by its valued members Mr. Hodgkinson and Mr. Fairbairn.

I may further state, that in the recent improvements in railways the aid of scientific investigations was called for by the civil engineer, to assist him in determining with accuracy the power to be provided for attaining the high velocities of fifty and sixty miles an hour ; and it was found and admitted by the most eminent engineers, that the very best data for this purpose, and indeed the only experiments of any practical value, were those which had been provided for some years ago by a Committee of the British Association, and published in our Transactions. The Institution of Civil Engineers thus gave testimony to the practical value of our researches by adopting their results.

However imperfect my knowledge of such subjects may be, I must now notice that the last volume of our Reports contains two contributions to experimental philosophy, in which subjects of the deepest theoretical and practical interest have been elucidated, at the request of the Association, by the labours of its foreign coadjutors.

That some substance of a peculiar kind everywhere exists, or is formed in the atmosphere by electrical agency, both natural and artificial, had long been suspected, especially from the persistency of the odour developed by such agency, and its transference by contact to other matter. Professor Schönenbein, to whom I shall hereafter advert as the author of a great, new practical discovery, is, however, the first philosopher who undertook to investigate the nature of that substance ; and though the investigation is not yet complete, he has been enabled to report no inconsiderable progress in this difficult and refined subject of research.

A request from the Association to Professor Bunsen of Marburg, and our countryman Dr. Lyon Playfair, coupled with a contribution of small amount towards the expenses involved in the undertaking, has produced a report on the conditions and products of iron-furnaces which is of considerable value in a commercial view to one of the most important of our manufactures, and possesses at the same time a very high interest to chemical science in some of the views which it develops. On the one hand it exhibits an entirely new theory of the reduction, by cyanogen gas as the chief agent, of iron from the ore ; on the other it shows, that in addition to a vast saving of fuel, about 2 cwt. of sal-ammoniac may daily be collected at the single establish-

ment of Alfreton, where the experiments were made ; thus leading us to infer that in the iron-furnaces of Britain there may be obtained from vapour which now passes away, an enormous quantity of this valuable substance, which would materially lessen the dependence of our agriculturists on foreign *guano*. It is indeed most gratifying to observe, that in pursuing this inquiry into the gaseous contents of a blazing furnace of great height, our associates traced out, foot by foot, the most recondite chemical processes, and described the fiery products with the same accuracy as if their researches had been made on the table of a laboratory.

Weighed however only in the scales of absolute and immediate utility, the remarkable results of these skilful and elaborate experiments give them a character of national importance, and justly entitle the authors and the body which has aided them to the public thanks.

After this glance at the subjects of purely physical science treated of in the last volume of our Transactions, let us now consider the domains of natural history ; and as one of the cultivators of a science which has derived its main support and most of its new and enlarged views from naturalists, let me express the obligation which geologists are under to this Association, for having aided so effectively in bringing forth the zoological researches of Owen, Agassiz, and Edward Forbes. These three distinguished men have themselves announced, that in default of its countenance and assistance, they would not have undertaken, and never could have completed, some of their most important inquiries. Agassiz, for example, had not otherwise the means of comparing the ichthyolites of the British Isles with those of the continent of Europe. Without this impulse, Owen would not have applied his profound knowledge of comparative anatomy to British fossil saurians ; and Edward Forbes might never have been the explorer of the depths of the *Ægean*, nor have revealed many hitherto unknown laws of submarine life, if his wishes and suggestions had not met with the warm support of this body, and been supported by its strongest recommendations to the Naval authorities.

These allusions to naturalists, whose works have afforded the firmest supports to geology, might lead me to dilate at length on the recent progress of this science ; but as the subject has been copiously treated at successive anniversaries of the Geological Society of London, and has had its recent advances so clearly enunciated by the actual President of that body who now presides over our Geological Section, I shall restrain my “ *esprit de corps* ” whilst I briefly advert to some of the prominent advances which geologists have made. When our associate Conybeare reported to us at our second meeting, on the actual state and ulterior prospects of what he well termed the “ *archæology of the globe*,” he dwelt with justice on the numerous researches

in different countries which had clearly established the history of a descent as it were into the bowels of the earth—which led us, in a word, downwards through those newer deposits that connect high antiquity with our own period, into those strata which support our great British coal-fields. Beyond this however the perspective was dark and doubtful—

“Res altâ terrâ et caligine mersas.”

Now, however, we have dispersed this gloom, and by researches first carried out to a distinct classification in the British Isles, and thence extended to Russia and America, geologists have shown that the records of succession, as indicated by the entombment of fossil animals, are as unequivocally developed in these very ancient or palæozoic strata as in any of the overlying or more recently formed deposits. After toiling many years in this department of the science, in conjunction with Sedgwick, Lonsdale, De Verneuil, Keyserling, and others of my fellow-labourers, I have arrived at the conclusion, that we have reached the very genesis of animal life upon the globe, and that no further “vestigia retrorsum” will be found, beneath that protozoic or Lower Silurian group in the great inferior mass of which no vertebrated animal has yet been detected, amid the countless profusion of the lower orders of marine animals entombed in it.

But however this may be, it is certain that in the last few years all Central and Eastern Europe and even parts of Siberia have been brought into accordance with British strata. France has been accurately classified and illustrated by the splendid map of Elie de Beaumont and Dufrenoy; and whilst, by the labours of Deshayes and others, its tertiary fossils have been copiously described, the organic remains of its secondary strata are now undergoing a complete analysis in the beautiful work of M. Alcide d'Orbigny. Belgium, whose mineral structure and geological outlines have been delineated by D'Omalius d'Halloy and Dumont, has produced very perfect monographs of its palæozoic and tertiary fossils; the first in the work of M. de Koningk, the second in the recently published monograph of M. Nyst. Germany, led on by Von Buch, has shown that she can now as materially strengthen the zoological and botanical groundworks of the science, as in the days of Werner she was eminent in laying those mineralogical foundations which have been brought so near to perfection by the labours of several living men. So numerous in fact have been the contributions of German geologists, that I cannot permit myself to specify the names of individuals in a country which boasts so many who are reading closely in the steps of an Ehrenberg and a Rosé. As distinctly connected, however, with the objects of this Meeting, I must be permitted to state that the eminent botanist Göppert, whose works, in combination with those of Adolphe Brongniart in France, have shed so much light on fossil plants, has just sent to me, for communication to our Geological Section, the results of

his latest inquiries into the formation of the coal of Silesia—results which will be the more interesting to Dr. Buckland and the geologists of England, because they are founded on data equally new and original. Italy has also to a great extent been presented to us in its true general geological facies, through the labours of Sismonda, Marmora, Pareto and others; whilst our kinsmen of the far West have so laid open the structure of their respective States, that our countryman Lyell has informed us, that the excellent map which accompanies his work upon North America is simply the grouping together of data prepared by native State geologists, which he has paralleled with our well-known British types.

If then the astronomer has, to a vast extent, expounded the mechanism of the heavens; if lately, through the great telescope of our associate the Earl of Rosse, he has assigned a fixity and order to bodies which were previously viewed as mere nebulae floating in space, and has also inferred that the surface-cavities in our nearest neighbour of the planetary system are analogous to the volcanic apertures and depressions of the earth; the geologist, contributing data of another order to the great storehouse of natural knowledge, has determined, by absolute and tangible proofs, the precise manner in which our planet has been successively enveloped in divers cerements, each teeming with peculiar forms of distinct life, and has marked the revolutions which have interfered with these successive creations, from the earliest dawn of living things to the limits of the historic æra. In short, the fundamental steps gained in geology, since the early days of the British Association, are so remarkable and so numerous, that the time has now come for a second report upon the progress of this science, which may I trust be prepared for an approaching, if not for the next Meeting.

Intimately connected with these broad views of the progress of geology is the appearance of the first volume of a national work by Sir Henry De la Beche and his associates in the Geological Survey of Great Britain. Following, as it does, upon the issue of numerous detailed coloured maps and sections, which for beauty of execution and exactness of detail are unrivalled, I would specially direct your attention to this new volume, as affording the clearest evidence that geology is now strictly brought within the pale of the fixed sciences. In it are found graphic descriptions of the strata in the South-West of England and South Wales, whose breadth and length are accurately measured, whose mineral changes are chemically analysed, and whose imbedded remains are compared and determined by competent palæontologists. The very statistics of the science are thus laid open, theory is made rigorously to depend on facts, and the processes and produce of foreign mines are compared with those of Britain.

When we know how intimately the Director-General of this Survey and

his associates have been connected with the meetings of the British Association, and how they have freely discussed with us many parts of their researches—when we recollect that the geologist of Yorkshire, our invaluable Assistant General Secretary, around whom all our arrangements since our origin have turned, and to whom so much of our success is due, occupies his fitting place among these worthies—that Edward Forbes, who passed as it were from this Association to the *Æ*gean, is the palæontologist of this Survey; and again when we reflect, that if this Association had not repaired to Glasgow, and there discovered the merits of the Survey of the Isle of Arran by Mr. Ramsay, that young geologist would never have become a valuable contributor to the volume under consideration—it is obvious from these statements alone, that the annual visits of our body to different parts of the Empire, by bringing together kindred spirits, and in testing the natural capacity of individuals, do most effectually advance science and benefit the British community.

Whilst considering these labours of the Government geologists, I shall now specially speak of those of Professor E. Forbes in the same volume, because he here makes himself doubly welcome, by bringing to us as it were upon the spot the living specimens of submarine creatures, which through the praiseworthy enthusiasm of Mr. M<sup>c</sup>Andrew, one of our members, who fitted out a large yacht for natural-history researches, have been dredged up this summer by these naturalists from the southern coast, between the Land's End and Southampton. As a favourite yachting port like Southampton may, it is hoped, afford imitators, I point out with pleasure the liberal example of Mr. M<sup>c</sup>Andrew, who not professing to describe the specimens he collects, has on this, as on former occasions, placed them in the hands of the members best qualified to do them justice, and is thus a substantial promoter of science.

The memoir, then, of Edward Forbes in the Government Geological Survey to which I would allude, is, in truth, an extension of his views respecting the causes of the present distribution of plants and animals in the British Isles, made known at the last meeting of the British Association. As this author has not only shown the application of these ideas to the researches of the British Geological Survey, but also to the distribution of animals and plants over the whole earth, it is evident that these views, in great part original, will introduce a new class of inquiries into natural history, which will link it on more closely than ever to geology and geography. In short, this paper may be viewed as the first attempt to explain the *causes* of the zoological and botanical features of any region anciently in connexion. Among the new points which it contains, I will now only mention, that it very ingeniously (and I think most satisfactorily) explains the origin of the

peculiar features of the botany of Britain—the theory of the origin of Alpine Floras distributed far apart—the peculiarity of the zoology of Ireland as compared with that of England—the presence of the same species of marine animals on the coasts of America and Europe—the specialities of the marine zoology of the British seas called for by this Association—the past and present distribution of the great Mediterranean Flora;—and lastly, it applies the knowledge we possess of the distribution of plants to the elucidation of the history of the superficial detritus, termed by geologists the “Northern Drift.”

Amid the numerous subjects for reflection which the perusal of this memoir occasions, I must now restrict myself to two brief comments. First, to express my belief that even Humboldt himself, who has written so much and so admirably on Alpine floras, will admit that our associate's explanation of the origin of identity removes a great stumbling-block from the path of botanical geographers. Secondly, having myself for some years endeavoured to show, that the Alpine glacialists had erroneously applied their views, as founded on terrestrial phenomena, to large regions of Northern Europe, which must have been under the sea during the distribution of erratic blocks, gravel and boulders, I cannot but consider it a strong confirmation of that opinion, when I find so sound a naturalist as Edward Forbes sustaining the same view by perfectly independent inferences concerning the migration of plants to isolated centres, and by a studious examination and comparison of all the sea shells associated with these transported materials. And if I mistake not, my friend Mr. Lyell will find in both the above points, strong evidences in support of his ingenious climatal theories.

Recent as the blocks and boulders to which I have alluded may seem to be, they were however accumulated under a glacial sea, whose bottom was first raised to produce that connexion between the continent and Britain, by which the land animals migrated from their parent East to our western climes; a connexion that was afterwards broken through by the separation of our islands, and by the isolation in each of them of those terrestrial races which had been propagated to it. This latter inference was also, indeed, thoroughly sustained by the researches of Professor Owen, communicated to this Association; first, in the generalization by which his report on the Extinct Mammals of Australia is terminated, and still more in detailed reference to our islands in his recently published work ‘On the Extinct Fossil British Mammalia,’—a work which he has stated in his dedication originated at the call of the British Association. Professor Owen, who supports me in the chair, adds, indeed, greatly to the strength of our present Meeting, by also acting as the President of one of our Sections, which having in its origin been exclusively occupied in the study of Medicine, is now more pecu-

liarly devoted to the cultivation of Physiology. Under such a leader I have a right to anticipate that this remodelled Section will exhibit evidences of fresh vigour, and will clearly define the vast progress that has been made in general and comparative anatomy since the days of Hunter and of Cuvier, for so large a part of which we are indebted to our eminent associate.

Assembled in a county which has the good fortune to have been illustrated by the attractive and pleasing history of the naturalist of Selborne, I am confident that our Fourth Section, to whose labours I would now specially advert, will yield a rich harvest, the more so as it is presided over by that great zoologist who has enriched the adjacent Museum of the Naval Hospital at Haslar with so many animals from various parts of the world, and has so arranged them as to render them objects well-worthy of your notice. The report of Sir John Richardson in the last volume, on the Fishes of China, Japan and New Zealand, when coupled with his account in former volumes of the Fauna of North America, may be regarded as having completely remodelled our knowledge of the geographical distribution of fishes; first by affording the data, and next by explaining the causes through which a community of ichthyological characters is in some regions widely spread, and in others restricted to limited areas. We now know, that just as the lofty mountain is the barrier which separates different animals and plants, as well as peculiar varieties of man, so the deepest seas are limits which peremptorily check the wide diffusion of certain genera and species of fishes; whilst the interspersion of numerous islands, and still more the continuance of lands throughout an ocean, ensures the distribution of similar forms over many degrees of latitude and longitude.

The general study, indeed, both of zoology and botany has been singularly advanced by the labours of the Section of Natural History. I cannot have acted for many years as your General Secretary without observing, that by the spirit in which this Section has of late years been conducted, British naturalists have annually become more philosophical, and have given to their inquiries a more physiological character, and have more and more studied the higher questions of structure, laws and distribution. This cheering result has mainly arisen from the personal intimacy brought about among various individuals, who, living at great distances from each other, were previously never congregated; and from the mutual encouragement imparted by their interchange of views and their comparisons of specimens. Many active British naturalists have in fact risen up since these Meetings commenced, and many (in addition to the examples already alluded to) have pursued their science directly under the encouragement we have given them. The combination of the enthusiastic and philosophic spirit thus engendered among the naturalists has given popularity to their department of science,

and this Section, assuming an importance to which during our earliest Meetings it could show comparatively slender claims, has vigorously revived the study of natural history, and among other proofs of it, has given rise to that excellent publishing body the Ray Society, which holds its anniversary during our sittings. Any analysis of the numerous original and valuable reports and memoirs on botanical and zoological subjects which have enriched our volumes is forbidden by the limits of this address, but I cannot omit to advert to the extensive success of Mr. H. Strickland's report on Zoological Nomenclature, which has been adopted and circulated by the naturalists of France, Germany, Sweden and America, and also by those of Italy headed by the Prince of Canino. In each of these countries the code drawn up by the Association has been warmly welcomed, and through it we may look forward to the great advantage being gained, of the ultimate adoption of an uniform zoological nomenclature all over the globe.

Whilst investigations into the geographical distribution of animals and plants have occupied a large share of the attention of our Browns and our Darwins, it is pleasing to see that some members, chiefly connected with physical researches, are now bringing these data of natural history to bear upon climatology and physical geography. A committee of our naturalists, to whom the subject was referred, has published in our last volume an excellent series of instructions for the observation of the periodical phænomena of animals and plants, prepared by our foreign associate M. Quetelet, the Astronomer Royal of Belgium. Naturalists have long been collecting observations on the effects produced by the annual return of the seasons, but their various natural-history calendars being local, required comparison and concentration, as originally suggested by Linnæus. This has now for the first time been executed by the Belgian Astronomer, who following out a plan suggested by himself at our Plymouth Meeting, has brought together the contributions and suggestions of the naturalists of his own country. When M. Quetelet remarks, "that the phases of the smallest insect are bound up with the phases of the plant that nourishes it; that plant itself being in its gradual development the product, in some sort, of all anterior modifications of the soil and atmosphere," he compels the admission, that the study which should embrace all periodical phænomena, both diurnal and annual, would of itself form a science as extended as instructive.

Referring you to M. Quetelet's report for an explanation of the dependence of the vegetable and animal kingdoms on the meteorology and physics of the globe, and hoping that the simultaneous observations he inculcates will be followed up in Britain, I am glad to be able to announce, that the outline of a memoir on physical geography was some months ago put into my hands by Mr. Cooley, which in a great degree coinciding with the system of M.

Quetelet, has ultimately a very different object. M. Quetelet chiefly aims at investigating the dependence of organized bodies on inorganized matter, by observing the periodical phenomena of the former. Mr. Cooley seeks to obtain an acquaintance with the same phenomena for the sake of learning and registering comparative climate as an element of scientific agriculture. Speaking to you in a county which is so mainly dependent on the produce of the soil, I cannot have a more favourable opportunity for inculcating the value of the suggestions of this British geographer. The complete establishment of all the data of physical geography throughout the British Islands ; *i. e.* the registration of the mean and extremes of the temperature of the air and of the earth ; the amount of conduction, radiation, moisture and magnetism ; the succession of various phases of vegetation, &c. (with their several local corrections for elevation and aspect), must certainly advance the cause of science, and promote the material interests of our country.

A minute knowledge of all the circumstances of climate cannot but be of importance to those whose industry only succeeds through the co-operation of nature, and it may therefore be inferred that such a report as that with which I trust Mr. Cooley will favour us, if completed by the addition of tables, must prove to be a most useful public document. Imbibing the ardour of that author, I might almost hope that like researches in physical geography may enable us to define, in the language of the poet,

“Et quid quæque ferat regio, et quid quæque recuset.”

At all events, such a report will tend to raise physical geography in Britain towards the level it has attained in Prussia under the ægis of Humboldt and Ritter, and through the beautiful maps of Berghaus.

Though our countryman, Mr. Keith Johnston, is reproducing, in attractive forms, the comparative maps of the last-mentioned Prussian author, much indeed still remains to be done in Britain, to place the study of physical geography on a basis worthy of this great exploring and colonizing nation ; and as one of the highly useful elementary aids to the training of the youthful mind to acquire a right perception of the science, I commend the spirited project of M. Guerin of Paris, to establish in London a georama of vast size which shall teach by strong external relief, the objects and details of which he will in the course of this week explain to the geographers present.

Reverting to economical views and the improvement of lands, I would remind our agricultural members, that as their great practical Society was founded on the model of the British Association, we hope they will always come to our Sections for the solution of any questions relating to their pursuits to which can be given a purely scientific answer. If they ask for the explanation of the dependence of vegetation upon subsoil or soil, our geologists and botanists are ready to reply to them. Is it a query on the com-

parison of the relative value of instruments destined to oœconomize labour, the mechanicians now present are capable of answering it. And if, above all, they wish us to solve their doubts respecting the qualitics of soils and the results of their mixtures, or the effects of various manures upon them, our chemists are at hand. One department of our Institution is in fact styled the Section of Chemistry and Mineralogy, with their applications to Agriculture and the Arts, and is officered in part by the very men, Johnston, Daubeny and Playfair, to whom the agriculturists have, in nearly all cases, appealed. The first-mentioned of these was one of our earliest friends and founders; the second had the merit of standing by the British Association at its first meeting, and there inviting us to repair to that great University where he is so much respected, and where he is now steadily determining, by elaborate experiments, the dependence of many species of plants on soil, air and stimulus; whilst the third has already been alluded to as one of our best actual contributors.

If in reviewing our previous labours I have endeavoured to gain your attention by some incidental allusions to our present proceedings, I have yet to assure you, that the memoirs communicated to our Secretaries are sufficiently numerous to occupy our Sections during the ensuing week with all the vigour which has marked our opening day. Among the topics to which our assembling at Southampton gives peculiar interest, I may still say that if geologists should find much to interest them in the Isle of Wight, the same island contains a field for a very curious joint discussion between them and the mathematicians, with which I became acquainted in a previous visit to this place. It is a discovery by Colonel Colby, the Director of the Trigonometrical Survey, of the existence of a notable attraction of the plumb-line to the south, at the trigonometrical station called Dunnose, on Shanklin Down. The details of this singular phænomenon, which has been verified by observations with the best zenith sectors, will be laid before the Sections. In the meantime, we may well wonder, that on the summit of a chalk hill of low altitude which is bounded on the south by the sea (near whose level the deviation is scarcely perceptible), there should exist an attraction of more than half the intensity of that which was registered by Maskelyne, when he suspended a plummet at the side of the lofty Scottish mountain of Schiehallion! If those of our geologists, who like Mr. Hopkins of Cambridge have entered the rich field of geological dynamics, cannot explain this remarkable fact, by connecting it with the ridge of dislocated strata that runs through the island as a back-bone from west to east, may we venture to refer it to dense plutonic masses of rock ranging beneath the surface, parallel to the line of displacement of the deposits?

Another local subject—one indeed of positive practical interest—that

stands before us for discussion, is, whether, by persevering in deepening the large shaft which they have sunk so deep into the chalk near this town, the inhabitants of Southampton may expect to be eventually repaid, like those of Paris, by a full supply of subterranean water, which shall rise to the surface of the low plateau on which the work has been undertaken? On no occasion, I must observe, could this town be furnished with a greater number of willing counsellors, whose opinions will, it is hoped, be adequately valued by the local authorities. The question whether this work ought to be proceeded with or not, will however, I apprehend, be most effectively answered by those geologists who are best acquainted with the sections in the interior of this county, and with the levels at which the upper greensand and subcretaceous strata there crop out and receive the waters, which thence flow southwards beneath the whole body of chalk of the hills in the south of Hampshire.

Again, as we are now assembled in the neighbourhood of our great naval arsenal—as some of its functionaries, including the Admiral on the station, have honoured us with their support, and as, further, I am now speaking in a town whose magnificent new docks may compete with any for bold and successful engineering, I must say a few words on our naval architecture, the more so as we have here a very strong Mechanical Section, presided over by that eminent mechanician Professor Willis, assisted by the great dynamical mathematician Dr. Robinson, and that sound engineer George Dennie. Duly impressed with the vast national importance of this subject, and at the same time of its necessary dependence on mathematical principles, the British Association endeavoured in its earliest days to rouse attention to the state of ship-building in England, and to the history of its progress in France and other countries, through a memoir by the late Mr. G. Harvey. It was then contended, that notwithstanding the extreme perfection to which the internal mechanism of vessels had been brought, their external forms or lines, on which their sailing so much depends, were deficient as to adjustment by mathematical theory. Our associate Mr. Scott Russell has, you know, ably developed this view. Experimenting upon the resistance of water, and ascertaining with precision the forms of vessels which would pass through it with the least resistance, and consequently with the greatest velocity, he has contributed a most valuable series of memoirs, accompanied by a great number of diagrams, to illustrate his opinions and to show the dependence of naval architecture on certain mathematical lines. Employed the meantime by merchants on their own account, to plan the construction of sailing ships and steamers, Mr. Scott Russell has been so successful in combining theory with practice, that we must feel satisfied in having at different meetings helped him onwards by several money grants; our only

regret being, that our means should not have permitted us to publish the whole number of diagrams of the lines prepared by this ingenious author.

But however desirous to promote knowledge on this point, the men of science are far from wishing not to pay every deference to the skilful artificers of our wooden bulwarks, on account of their experience and practical acquaintance with subjects they have so long and so successfully handled. We are indeed fully aware, that the naval architects of the Government, who construct vessels carrying a great weight of metal and requiring much solidity and capacious stowage, have to solve many problems with which the owners of trading vessels or packets have little concern. All that we can wish for is, that our naval arsenals should contain schools or public boards of ship-building, in which there might be collected all the "constants of the art," in reference to capacity, displacement, stowage, velocity, pitching and rolling, masting, the effect of sails and the resistance of fluids. Having ourselves expended contributions to an extent which testify, at all events, our zeal in this matter, we are, I think, entitled to express a hope, that the data derived from practice by our eminent navigators may be effectively combined with the indications of sound theory prepared by approved cultivators of mathematical and mechanical science.

I cannot thus touch upon such useful subjects without saying, that our Statistical Section has been so well conducted by its former presidents, that its subjects, liable at all times to be diverted into moral considerations and thence into polities, have been invariably restricted to the branch of the science which deals in facts and numbers; and as no one individual has contributed more to the storehouse of such valuable knowledge than Mr. George Porter (as evidenced even by his report in our last volume), so may we believe that in this town, with which he is intimately connected, he will contribute to raise still higher the claims of the Section over which he is so well qualified to preside.

If in this discourse I have referred more largely to those branches of science which pertain to the general division of natural history, in which alone I can venture to judge of the progress which others are making, let me however say, that no member of this body can appreciate more highly than I do, the claims of the mathematical and experimental parts of philosophy, in which my friend Professor Baden Powell of Oxford, who supports me on this occasion as a Vice-President, has taken so distinguished a part. No one has witnessed with greater satisfaction the attendance at our former meetings of men from all parts of Europe the most eminent in these high pursuits. No one can more glory in having been an officer of this Association when it was honoured with the presence of its illustrious correspondent Bessel, than whom the world has never produced a more profound astronomer.

among his numerous splendid discoveries he furnished astronomers with what they had so long and so ardently desired—a fixed and ascertained point in the immensity of space, beyond the limits of our own sidereal system, it is to Bessel, as I am assured by a contemporary worthy of him, that Englishmen owe a debt of gratitude for his elaborate discussion of the observations of their immortal Bradley, which, in his hands, became the base of modern astronomy.

Passing from this recollection, so proud yet so mournful to us all as friends and admirers of the deceased Prussian astronomer, can any one see with more delight than myself the brilliant concurrence at our present Meeting of naturalists, geologists, physiologists, ethnologists and statists, with mathematicians, astronomers, mechanicians, and experimental philosophers in physics and in chemistry? Surely then I may be allowed to signalize a particular ground of ratification among so many, in the presence at this Meeting of two individuals in our Experimental Sections, to one of whom, our eminent foreign associate Ørsted, we owe the first great link between electric and magnetic phænomena, by showing the magnetic properties of the galvanic current; whilst the other, our own Faraday, among other new and great truths which have raised the character of English science throughout the world, obtained the converse proof by evoking electricity out of magnets. And if it be not given to the theologian whom you have honoured with this chair, to explain how such arcana have been revealed, still, as a worshiper in the outer portico of the temple of physical science, he may be permitted to picture to himself the delight which the Danish philosopher must have felt, when on returning to our shores, after an absence of a quarter of a century, he found that the grand train of discovery of which he is the progenitor had just received its crowning accession in England from his former disciple, who, through a long and brilliant series of investigations peculiarly his own, has shown that magnetic or dia-magnetic forces are distributed throughout all nature.

And thus shall we continue to be a true British Association, with cosmopolitan connexions, so long as we have among us eminent men to attract such foreign contemporaries to our shores. If then at the last assembly we experienced the good effects which flowed from a concentration of mathematicians and magneticians, drawn together from different European kingdoms—if then also the man\* of solid learning, who then represented the United States of America, and who is now worthily presiding over the Cambridge University of his native soil, spoke to us with chastened eloquence of the benefits our Institution was conferring on mankind; let us rejoice at this Meeting is honoured by the presence of foreign philosophers as distinguished as those of any former year.

\* Mr. Everett.

Let us rejoice that we have now among us men of science from Denmark, Sweden, Russia, Prussia, Switzerland, Italy and France. The King of Denmark, himself personally distinguished for his acquaintance with several branches of natural history, and a warm patron of science, has honoured us by sending hither, not only the great discoverer Oersted, who evincing fresh vigour in his mature age brings with him new communications on physical science, but also my valued friend, the able geologist and chemist Førchhammer, who has produced the first geological map of Denmark, and who has presented to us a lucid memoir on the influence exercised by marine plants on the formation of ancient crystalline rocks, on the present sea and on agriculture.

As these eminent men of the North received me as the General Secretary of the British Association with their wonted cordiality at the last Scandinavian Assembly, I trust we may convince them that the sentiment is reciprocal, and that Englishmen are nearly akin to them in the virtues of friendship and hospitality which so distinguish the dwellers within the circle of Odin.

Still adverting to Scandinavia, we see here a deputy from the country of Linnaeus in the person of Professor Svanberg, a successful young experimenter in physics, who represents his great master Berzelius—that profound chemist and leader of the science of the North of Europe, who established on a firm basis the laws of atomic weights and definite proportions, and who has personally assured me, that if our Meeting had not been fixed in the month of September, when the agriculturists of Sweden assemble at Stockholm, he would assuredly have repaired to us. And if the same cause has prevented Nilsson from coming hither, and has abstracted Retzius from us (who was till within these few days in England), I cannot mention these distinguished men, who earnestly desired to be present, without expressing the hope, that the memoirs they communicate to us may give such additional support to our British ethnologists, as will enable this new branch of science, which investigates the origin of races and languages, to take the prominent place in our assemblies to which it is justly entitled.

The Royal Academy of Berlin, whose deputies on former occasions have been an Ehrenberg, a Bueh, and an Erman, has honoured us by sending hither M. Heinrich Rosé, whose work on chemical analysis is a text-book even for the most learned chemists in every country; and whilst his researches on the constitution of minerals, like those of his eminent brother Gustave on their form, have obtained for him so high a reputation, he now brings to us the description of a new metal which he has discovered in the Tantalite of Bavaria.

Switzerland has again given to us that great master in palaeontology, Agassiz, who has put arms into the hands of British geologists with which they have

conquered vast regions, and who now on his road to new fields in America, brings to us his report on the fossil fishes of the basin of London, which will, he assures me, exceed in size all that he has ever written on ichthyolites.

From the same country we have our warm friend Professor Schönbein, who, in addition to his report on Ozone, to which I have already referred, has now brought to us a discovery of vast practical importance. The "gun-cotton" of Schönbein, the powers of which he will exhibit to his colleagues, is an explosive substance, which, exercising a stronger projectile force than gunpowder, is stated to possess the great advantages over it of producing little or no smoke or noise, and of scarcely soiling fire-arms; whilst no amount of wet injures this new substance, which is as serviceable after being dried as in its first condition. The mere mention of these properties, to which our associate lays claim for his new material, is sufficient to show its extraordinary value in all warlike affairs, as also in every sort of subterranean blasting, and may well lead me to say, that this discovery, which almost rivals the invention of that substance which it is destined to supplant, will signally mark this meeting at Southampton. But, as if British chemistry were not to be outdone, here also there will be promulgated, for the first time, the very remarkable discovery of our countryman Mr. Groves, of the decomposition of water by heat.

Professor Matteucci of Modena, who joined us at the York meeting, and then explained his various new and delicate investigations in electro-physiology, again favours us with a visit, as the representative of the Italian Philosophical Society of Modena and of the University of Pisa. This ingenious philosopher, who has measured the effect of galvanic currents in exciting through the nerves mechanical force in the muscles, doubtless brings with him such interesting contribution as will add great additional interest to the proceedings of the Physiological Section.

Among these sources of gratification, no one has afforded me sincerer pleasure than to welcome hither the undaunted Siberian explorer, Professor von Middendorff. Deeply impressed as I am with the estimation in which science is held by the illustrious ruler of the empire of Russia, I cannot but hope that the presence of this traveller, so signalized by his enterprising exploits, may meet with a friend in every Englishman who is acquainted with the arduous nature of his travels. To traverse Siberia from south to north and from west to east; to reach by land the extreme northern headland of Taimyr; to teach us, for the first time, that even to the latitude of  $72^{\circ}$  north, trees with stems extend themselves in that meridian; that crops of rye, more abundant than in his native Livonia, grow beyond Yakutsk, on the surface of that frozen subsoil, the intensity and measure of cold in which he has determined by thermometric experiments;

to explain, through their language and physical form, the origin of tribes now far removed from their parent stock; to explore the far eastern regions of the Sea of Okhotsk and of the Shantar Isles; to define the remotest north-eastern boundary between China and Russia; and finally to enrich St. Petersburg with the natural productions, both fossil and recent, of all these wild and untrodden lands, are the exploits for which the Royal Geographical Society of London has, at its last meeting, conferred its Gold Victoria Medal on this most successful explorer. Professor Middendorff now visits us to converse with our naturalists most able to assist him, and to inspect our museums, in which, by comparison, he can best determine the value of specific characters before he completes the description of his copious accumulations; and I trust that during his stay in England he will be treated with as much true hospitality as I have myself received at the hands of his kind countrymen.

It is impossible for me to make this allusion to the Russian empire, without assuring you that our allies in science on the Neva, who have previously sent to us a Jacobi and a Kupffer, are warmly desirous of continuing their good connexion with us. It was indeed a source of great pleasure to me to have recently had personal intercourse in this very town with that eminent scientific navigator Admiral Lütke, in whose squadron His Imperial Highness the Grand Duke Constantine was acquiring a knowledge of his maritime duties. Besides the narrative of his former voyages, Lütke has since published an account of the periodical tides in the Great Northern Ocean and in the Glacial Sea, which I have reason to think is little known in this country. Having since established a *hypsalograph* in the White Sea, and being also occupied from time to time in observations in Behring's Straits, the Russians will soon be able to provide us with other important additions to our knowledge of this subject. Separated so widely as Admiral Lütke and Dr. Whewell are from each other, it is pleasing to see, that the very recommendation which the last-mentioned distinguished philosopher of the tides has recently suggested to me, as a subject to be encouraged by this Association, has been zealously advocated by the former. Let us hope then that this Meeting will not pass away without powerfully recommending to our own Government, as well as to that of His Imperial Majesty, systematic and simultaneous investigations of the tides in the Great Ocean, particularly in the Northern Pacific,—a subject (as Admiral Lütke well observes) which is not less worthy of special expeditions and of the attention of great scientific bodies, than the present inquiries into terrestrial magnetism; and one which, I may add, this Association will doubtless warmly espouse, since it has such strong grounds for being satisfied with the results which it has already contributed to obtain through its own grants, and by the researches of several of its associates.

Lastly, in alluding to our foreign attendants, let us hope that our nearest

neighbours may respond to our call, and may prove by their affluence to Southampton, that in the realms of science there is that "entente cordiale" between their great nation and our own, of which, at a former meeting, we were assured by the profound Arago himself.

No sooner was it made known that the Chair of Chemistry at this Meeting was to be filled by Michael Faraday, than a compeer worthy of him in the Academy of Sciences of Paris was announced in the person of M. Dumas. To this sound philosopher it is well known that we owe, not only the discovery of the law of substitution of types, which has so powerfully aided the progress of organic chemistry, but also the successful application of his science to the arts and useful purposes of life; his great work on that subject, 'La Chimie appliquée aux Arts,' being as familiar in every manufactory in England as it is upon the Continent.

Nor, if we turn from chemistry to geology, will such of us as work among the rocks be backward in welcoming the French geologists who may come to examine, in our own natural sections of the Isle of Wight, the peculiar development of their Paris basin, the identity of their chalk and our own, the fine sections of our greensand and of the Wealden formation of Mantell, and to determine with us *in situ* the strict relations of their Neocomian rocks with those peculiar strata which at Atherfield, in the Isle of Wight, have been so admirably illustrated by Dr. Fitton and other native geologists, and of which such beautiful and accurate diagrams have been prepared by Captain Ibbetson.

Will it not then be admitted, that the gathering together of such foreign philosophers, as those above mentioned, with our own men of science, must be productive of good results? Putting aside even the acknowledged fact, that numerous memoirs of value are published in one country which are unknown in another, where is the person, acquainted with the present accelerated march of science, who can doubt that the germs of discovery which are floating in the minds of distant contemporaries, must often be brought to maturity by the interchange of such thoughts? The collision of these thoughts may indeed be compared to the agency of the electric telegraph of Mr. Wheatstone, which concentrates knowledge from afar, and at once unites the extremities of kingdoms in a common circle of intelligence.

But although the distinguished foreigners to whom I have adverted, and others, including our welcome associate M. Wartmann, the Founder of the 'Audois Society, and M. Prevost of Geneva, on whose merits I would willingly dilate if time permitted it, are now collected around us; many, among whom I must name M. de Caumont, the President of the French Society for the Advancement of Science, have been prevented from honouring us with their presence, because the national meetings in their

several countries also occur in the month of September. To remedy this inconvenience, I ventured, when addressing you six years ago at the Glasgow meeting, to express the hope, that each of the European societies might be led to abstain during one year from assembling in its own country, for the purpose of repairing by its own deputies to a general congress, to be held at Frankfort or other central city under the presidency of the universal Humboldt. Had the preparation of the 'Cosmos' and other avocations of that renowned individual permitted him to accept this proposition, which the British Association would doubtless have supported, many benefits to science must have resulted, and each national body, on re-assembling the following year in its native land, would, I am convinced, have more vigorously resumed its researches.

But whether it be considered desirable or not to suspend the national scientific meetings during one year, I call on my countrymen and their foreign friends now present, to sustain the proposal for centralizing in a future year the representatives of the various branches of science of different countries, when they may at once learn the progress made in each nation, and when, at all events, they can so appoint the periods of their respective assemblies, as to prevent those simultaneous meetings in France, Germany, Scandinavia, Italy, Switzerland and England, which are so much to be deprecated as interfering with a mutual intercourse.

Finally, my fellow-labourers in science, if by our united exertions we have done and are doing good public service, let me revert once more to the place in which we are assembled, and express on your part the gratification I know you experience in being on this occasion as well supported by the noblemen, clergymen, and landed proprietors around Southampton, as by its inhabitants themselves—an union which thus testifies that the British Association embraces all parties and all classes of men.

Seeing near me Her Majesty's Secretary of State for Foreign Affairs, the Speaker of the House of Commons, and several persons of high station and great influence, who willingly indicate by their presence the sense they entertain of the value of our conferences and researches, let us welcome these distinguished individuals, as living evidences of that good opinion of our countrymen, the possession of which will cheer us onward in our career. And above all, let us cherish the recollection of this Southampton Meeting, which will be rendered memorable in our annals by the presence of the illustrious Consort of our beloved Sovereign, who participating in our pursuits, in some of which His Royal Highness is so well-versed, thus demonstrates that our Association is truly national, and enjoys the most general and effectual support throughout British society, from the humblest cultivators of science to the highest personages in the realm.

# DEVELOPMENT OF DIFFERENCE THE BASIS OF UNITY.

INTRODUCTORY LECTURE TO THE COURSES OF THE  
FACULTY OF ARTS AND LAWS,

DELIVERED IN  
UNIVERSITY COLLEGE, LONDON,  
OCTOBER 16, 1849.

BY  
ALEXANDER W. WILLIAMSON, PH.D.,

PROFESSOR OF PRACTICAL CHEMISTRY IN UNIVERSITY COLLEGE, LONDON.

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## ERRATA.

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Page 20, line 19, *for* "in both," *read* "to both."

Page 25, line 22, *for* "they would," *read* "would they?"

Page 25, line 27, *for* "in the event," *read* "on the events."

Page 33, line 5, *for* "compound," *read* "component."

Page 36, lines 24 and 28, *for* "phenomena," *read* "phenomenon."

Page 38, line 2, *for* "the development," *read* "the free development."

Page 41, line 28, *for* "nature," *read* "matter."



## INTRODUCTORY LECTURE.

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IN order to realise the object of this lecture, namely introducing you to the courses of the faculty of Arts and Laws, I purpose presenting to you considerations which are connected more or less distinctly with the subjects of all those courses, while belonging specially to no one of them.

After contemplating the leading events of history, the development and decline of powerful nations, and connecting them with the conduct and state of morality of the men who took part in them, one is repeatedly led to ask, what is to be the result of the events which are passing before our eyes, which we all more or less directly participate in furthering, whether we will or not. Most persons compare their own nation to former ones, as, for instance, the great Roman Empire, and seeing the crimes and faults to which the decomposition of that glorious body is often attributed, they seek in the social medium which surrounds them, the elements of a similar catastrophe.

Such meditations invariably produce in us a feeling of personal and moral responsibility, and I am convinced there are few who would hesitate to make the

greatest personal exertions and sacrifices, to ensure the prosperity and happiness of their country. Where this basis of patriotism exists in the masses, a rational guidance and direction is alone needed, to lead to the greatest results. The general direction is given by this elevated feeling, and it only remains to know the proper application of it to details of conduct. Now it is a truly wonderful fact, that the more elevated the moral feeling, that is, the greater the generality and extent of the principle, the more practically useful to all are the maxims deduced from it.

Thus the desire of doing good to our country is a noble feeling, which is productive of much good, but it leads to less important results than the more extensive and elevated feeling of devotion to Humanity. This fact, which is, now-a-days, very generally felt to be true, may be easily understood, by recalling to mind that the great element of strength is union; but union of action is only possible when based upon union of feeling and interest. To an object of benefit to all, all must ultimately rally their efforts, and results are thus obtained which could not be conceived on any other basis.

It may truly be taken as a characteristic of modern civilisation, that it tends more and more to unite by affections and interests; and the great results of moral and material improvement consist, on the one hand, in the union and harmony of feelings, and are accomplished, on the other, by the union of efforts. We may, indeed, say that the development of man consists in making him a nobler and more happy being, and therefore consider intellectual and material, especially in connexion with moral improvement;

every body will probably admit that a higher object cannot be proposed for one's exertions, than that of making one's fellow men more virtuous, and, consequently, more happy beings ; and that he who does most for this object, contributes most to the true development of his species. Indeed, it is a question which concerns every one, for each individual, in the course of his activity, takes some part, however small, in the development of humanity, though it be merely by procuring leisure for others, by performing menial duties which would absorb their time and attention. There are, I trust, few cases, even of the most cruel tyrants, who did not, in their way, endeavour to advance this great object ; but, unfortunately for mankind, they were guided by wrong notions as to the process by which it is attained. Philip II. himself committed the cruelties which have stamped his name with eternal shame, in the belief that he was serving the cause of true religion ; but so strong was the principle which he endeavoured to crush, that under its influence, a nation of poor fishermen wrested its independence from the most powerful throne of Christendom, and invigorated by the struggle, took for a time the lead in the movement of modern civilisation.

There is something truly instructive in the contemplation of such facts as these, of which the history of the human species affords innumerable instances, for they irresistibly force upon us the conviction of the existence of laws which direct the progress of the human species, and of which individual man is but an agent, and but too often a blind one. We see how the greatest human exertions fall powerless, when directed *against* the accomplishment of the great

events of civilisation, and we ask how such unfortunate attempts are to be avoided, unless by learning to direct our efforts in conformity to those laws of Nature, of which our very existence is a consequence.

But, although a close analysis of the facts leads us to consider the question as consisting simply in the opposition between truth and error, we must not forget that each party, in such struggles, believes himself the possessor of truth. Hence philosophers have endeavoured to discover an uniform test of truth, and the efforts of those who began by endeavouring to discover the fundamental nature of the question, have in general been productive of useful results, whereas those who attempted at once to solve it, have especially been useful by affording evidence of the inanity of such attempts.

Now it is a remarkable fact that, whenever the struggle develops itself between innovators or reformers and so-called conservatists, the former party is chiefly composed of people out of power, whereas the latter is chiefly composed of those who, by position or money, exercise governing functions. Hence it is often said, that reformers merely agitate to obtain a share of the profits, and as proof of this, it is remarked that, if at last they arrive at power, their measures are seldom more progressive than those of their opponents, and often less so. On the other hand, conservatives are said to oppose reform merely because their profits would suffer, and in evidence of this, they are reminded that a change of position is often productive of a change in their views.

Every subject admits of different representations, and it might be more useful to explain the fact, than

by odious sneers like the above, blame its existence. Indeed, it is not difficult to do so, and the difference of conclusions arrived at is strikingly illustrative of the moral principle of the propriety of seeking the admissible grounds and good side of men's actions. We proceed analytically, and examine what, in the relations between men in those different positions, should produce such a result. The functions of government may be considered as consisting chiefly in the maintenance, and more and more extensive application of such regulations as have been found useful. From the very fact of their practical point of view, persons performing such functions attach far more importance to a rule than to its rational explanation, which serves them chiefly as a support. With persons more especially occupied with reasoning than action, the state of the case is very different, as they are accustomed to consider rules and laws chiefly as exemplifying principles, or as affording the facts from which the rational conclusion is to them the chief result. Truth is here on the side of neither, but consists in understanding the mutual influence of these apparently conflicting parties.

But if it concerns all men, this question more especially concerns the English nation, for it is destined to act a leading part in the future events of civilisation; and it is most important that the English should feel at once the dignity and responsibility of the position which they already occupy in the human economy, and render themselves more and more worthy to retain and develop it for the benefit of all.

And indeed, this noble institution seems especially adapted to the development and propagation of such

knowledge, and is the first systematic step towards realising it. The object of all such institutions is, no doubt, the moral and intellectual union between men, but in the mode of attempting the solution of this problem we differ from many. This difference is, doubtless, destined to diminish in proportion as the truth of our principle becomes more generally understood. There is a fundamental distinction between the two modes, and its importance is such as to require our best attention. Each leads to results which are good or bad, according to the medium to which they are applied, and the circumstances by which they are surrounded, but being contrary in principle, so when applied to the same case they are contrary in immediate effects. On the one hand, it is attempted to unite men by a forced uniformity to certain doctrines, and the result obtained is an increase of the already existing differences. On the other hand, we take people as they are, and endeavour to do what good we can by developing those principles which are common to all. In the former instance it is attempted to jump at once to a distant result ; in the latter, we move on step by step from our actual position towards that result.

This has been repeatedly and clearly explained, and is eminently true ; but what I wish more especially to present to your view, is the fact that our true strength lies in belonging to no party, but tending to unite them, by making them meet upon common ground. To unite discordant elements one must be no partisan ; and whoever can do something towards the conciliation of conflicting parties for their mutual benefit, by studying and connecting that which is

good in them all, is indeed proved their superior, by their returning for these good offices nothing but hatred. Such is the position of this institution, of which the existence, unparalleled in the present age, is a realisation of the tendency to union on the basis and common ground of truth—tendency which it is our duty and interest to further to the utmost of our powers.

So wonderful is, however, the organisation of human society, that all movements concur more or less directly in furthering the same results, and even those who, not aware of their nature, exert themselves in a manner directly unfavourable to their realisation, are indirectly serviceable by the failure of their efforts ; which, showing clearly in successive instances what cannot be done, simplify more and more the question, and thus unite men's exertions in the true direction.

A most striking and decisive illustration of this truth, is afforded us by the effects in this country of all attempts to prevent the development of individual independence of thought and action, by compression and authority, which has acted as the chief engine for increasing differences and dissensions, and thus hastened the time when individual liberty and responsibility should be assumed as the basis of our social intercourse.

Protestantism would never have developed itself so rapidly without the persecutions of the Romish church ; but Protestantism has proclaimed to all countries that the masses must be treated as composed of reflecting individuals, whose reason must be convinced and not led blindfold, and especially in this country realised that result.

But this example needs further explanation, and we are thus led to the subject of this discourse—an examination of the destinies of England as an individual of the human family, in connection with the duties and responsibilities of its citizens.

Many eminent men have studied this question, and their conclusions, as far as they are known to me, are the elements and groundwork of the view I am about to present to you. In some cases the use I make of these conclusions, is different from that for which they were intended.

My mode of bringing the subject before you will be rather synthetical than analytical ; I will rather rise from the consideration of facts to establish principles, than begin by affirming principles, and then proceed to show that facts are in accordance with them. The reason for having chiefly recourse to this more difficult order, shall be explained in its place. I will now only state, that in such cases as I make use of the deductive or analytical method, it will be rather to explain principles by their applications than to prove their reality ; and in conformity to this same method I will, after contemplating facts existing at present, ascend to more and more remote, times in which the events were, in a manner, the principles of what we now see and do.

Nothing, perhaps, strikes an attentive observer of man more forcibly than the variety of faculties and powers possessed by different individuals, variety which is so immense that it would certainly be a difficult and probably an impossible task, to find in the whole human species two persons alike in bodily

and mental construction, much less in the circumstances of life and results of activity.

But the truth of this remark is more or less apparent according to the instance one examines, though taken among cotemporaries. Among Englishmen the variety is very great and striking, but the difference is greater still when one compares an Englishman with a Frenchman or Spaniard; but among less developed portions of our species, as, for instance, the natives of New Holland, the difference, though real, is far less apparent, and less extensive. The difference between the intellectual endowments and cultivation of any two of these savages, is certainly less than between two Englishmen taken from different spheres of life. Again, between men and women the difference is far greater in civilised nations, whether considered physically, morally, or in their modes of activity, than among savages, where many of the qualities and duties which we are accustomed to attribute exclusively to the one sex, are common to both.

By comparing the present state of the more civilised populations with their former condition, we discover a similar relation, for in the middle ages we have evidence that the differences of men's characters and powers in any one of the principal populations of Europe, were less extensive than at present, as the field of activity, whether mental or material, was also more limited. By ascending still further to the period of the Roman conquests, we find in many parts now far advanced in civilisation, a state of things somewhat analogous to what may be seen in these days among savage tribes.

Thus as different simultaneous groups contain a greater variety of individual differences, in proportion as they possess in a greater amount the results of civilisation, so any one group is found to contain a greater extent and variety of difference between the individuals which compose it in later, than it does in earlier times ; and this gradual increase of variety corresponds to an increase in civilisation. A law examined in its most simple form, is nothing but the affirmation of a general truth, and reciprocally the discovery of a natural principle, is the explanation of an existing law. We are governed by laws of Nature, and move in abeyance to them before we discover them by a study of this movement, and superadd our efforts (themselves natural) to the development of the existing tendency. The regularisation of these efforts constitutes good laws, which are those best adapted to our collective nature. To admit this and the reality of the above tendency, is to admit that the efforts of legislators should be directed to favouring the development of individual differences.

I alluded above to the relative amount of variety presented by different groups of the great human family, *i. e.*, nations, at the present time, in connexion with the relative variety contained in one of these groups at successive times. It now remains to consider whether the difference between nations themselves be increasing. Some might, perhaps, be disposed to consider this case as necessarily analogous to the preceding one, and therefore soluble by the principle established from it ; but I prefer giving it a distinct and independent consideration, conformably to the plan announced, especially

as it would probably be as difficult to prove *à priori* the analogy upon which the deduction would be founded.

It requires that we should be able to discover the facts which characterise each nation compared to the rest. But a nation is a collective body, and to be understood, requires the knowledge of its component parts and their mode of connexion. In the preceding instance, that of individual development, I was able to appeal to observations so simple, that I could fairly expect them to have been made by every one of my hearers ; but in the far more complicated case upon which we are now about to enter, I have not the same facilities, and must often content myself with affirming facts and connecting them together, and with those already known, as the extent of the subject necessarily precludes my entering upon the evidence of each. I must beg of my hearers similarly to suspend the consideration of such facts in themselves, in order to be able to accompany me in the study of their connexion ; it will afterwards be the more easy to verify each successively.

In viewing the more advanced part of Europe, one is at first struck by one general division between the populations which compose it. Its northern part is chiefly inhabited by Protestants, and its southern by Catholic populations. In France, which occupies an intermediate position, the existing predominance of the Catholic spirit and institutions, is the result of a long and fierce struggle.

The principle of this difference is important, and we may characterise it by the distinction between unity and toleration. Catholic populations have ideas

and forms in common, and attend less to the rational foundation of either, than to their immediate result ; seeing resemblances more easily than differences, they develope the former, and become aware of the latter only to blame them. Their method of judging others is simply a comparison with themselves, and the amount of resemblance to this standard is a direct measure of one's merit.

Protestant nations, on the contrary, are remarkable for the variety of forms of opinion which they present. Possessing many fundamental principles in common, each one applies them by his own reason, and looking chiefly at the foundation, they attach more value to the sincerity than particular form of a conviction. They consider individual freedom as the basis of concourse, and acknowledging differences of opinion and feeling as inevitable, endeavour to develope what is in common to all, upon this basis, rather than attempt to unite by the destruction of these differences.

It has been noticed, that in Catholic populations those branches of morality which concern directly the well-being of the mass, are more developed than those which affect it indirectly by the development of its component parts individually. Whereas among Protestants the reverse is true ; and personal morality and rectitude is more attended to, than the elevated feelings of fraternity and enthusiastic devotion to the good of others. In a word, the men of the south rely for their individual strength upon the firmness of their direct union, whereas the northern men develope their individual as the basis of their collective strength.

But to follow out the distinction, I must take an example, and will commence with that which presents

itself most readily, namely, in the relations between the French and English nations. Even in popular remarks which are repeated to satiety, we may find the expression of the fact ; thus, when the French are called vain and insincere, we must understand by the former term, that a Frenchman attaches extreme importance to the opinion entertained of him, and is accustomed to shape his demeanour and exterior so as to please those around him ; and by the latter, that their individual convictions are not so strong as to prevent their admitting conclusions for the sake of harmony, although not accordant with their existing personal ideas or feelings. Indeed their idea of human perfection consists in developing collective, at the expence of individual existence.

On the other side of the water *we* are called selfish, and oftentimes grovelling, and they thus admit, though with disapprobation, our general and practical habit of seeking individual power and development, while the second epithet bears testimony to our quiet matter-of-fact turn of mind, which shunning too general, or as we call them, high-flying conclusions, is accustomed to employ itself in matters of direct and evident utility.

It is also a general remark, that in France the ties of family are less close and firm than in this country, and that, on the other hand, people live far more in public. Considering families as the individual elements of which a nation is composed, it is evident that this fact is an exemplification of the same general difference.

Again, in the social and political structure of the two nations, a corresponding contrast may be

observed ; for, in truth, there does not exist in France an upper class in our sense of the word, and consequently, the middle class is obliged to have recourse to all sorts of expedients to maintain its existence ; whereas the characteristic of this country is the unparalleled development of the middle class, under the protection of the aristocracy.

The government of both countries is oligarchical, but in France it is spiritual, in England a temporal oligarchy. The city of Paris contains the most intelligent and active-minded part of the population ; and its spiritual dominion over the departments is most complete. Whereas England is in reality governed by the wealthy class, constantly recruited by the more active and enterprising of the population. In France the unity of command in the hands of the chief magistrate, is beyond comparison greater than here ; he is able to take the initiative, and oftentimes act in direct opposition to the will of the nation, of the deplorable results of which, instances are but too frequent ; whereas here, public opinion, vested chiefly in the monied class, has more than a veto, it habitually takes the lead in all normal operations.

But if the difference of national character be apparent between these two populations, it is even more so if we substitute in the comparison, the Spanish for the French nation ; for between a Spaniard and an Englishman, as between Spain and England, the difference is so immense that it almost becomes a difficulty to find analogy enough to institute a direct comparison, and for the clearness of the operation it will be desirable to keep in view France as a middle term.

The habits of mind and the feelings characteristic of Catholicism co-exist in France with a considerable amount of the contrary, with which they are often in warfare ; but in Spain Protestantism seems quite an impossible thing. In France the maintenance of Catholic forms has been essentially a measure of expediency, but in Spain it would have been quite impossible to remove them. The Spaniard has no vanity, for the spontaneous union of feelings and affections between man and man is so powerful and undisturbed by intellectual activity, that the agency of such a quality would have no object. It needs no effort in the Spaniard to conform to those around him, for he has no inclination to diverge. He has often been called proud, and perhaps not without reason, for the consciousness of personal dignity so remarkably developed in him, naturally tends towards that quality. Divergence of opinion which the Frenchman conceives but represses, is quite unnatural to the Spaniard, and appearing to him the most unpardonable of crimes, has been put down by him whenever occasion occurred with unequalled harshness.

The Inquisition was hardly needed to keep Spain in her faith, but would not have been so quietly tolerated, had not the population been entirely wanting in sympathy with independent thinkers, and indeed Spain stands alone in western Europe without one eminent philosopher to show.

Again, the existence of the absolute power in the French central government bears testimony, as all action does, to the simultaneous existence of an equal reaction ; but in Spain the government is truly powerless from the very excess of its power, which not

being at all resisted, is a mere empty form. Socially also Spain is farther removed from England than France, for a Spanish capitalist would be a most extraordinary phenomenon, and a monied class cannot, I believe, be said to exist, as the habits and pursuits of it are eminently distasteful to the Spaniard, whose highest ambition is to live a tranquil and happy life.

Considering the relative positions of the two sexes, France similarly occupies an intermediate position between Spain and England. For in Spain the respect for the fair sex almost amounts to adoration, and those qualities, both positive and negative, which belong especially to it, are national characteristics ; the most striking example of the former, is perhaps the predominance already alluded to, of the moral and affective over the intellectual and reflective qualities, and the latter is illustrated by the absence of ambition of material power and of responsible position.

England, on the other hand, is characterised by manly excellencies and defects—the intense and sustained activity which seems an essential of happiness to the Englishman, is accompanied no doubt by a considerable amount of selfishness, and the decision and strength of his character often leads him, when pursuing a conviction, to resort to measures of which a gentler and more effeminate nature would be incapable. At the same time women are probably more relieved in this country from arduous and active occupations than anywhere.

In France we see a certain balance and struggle between the two opposite principles. The manly qualities do not attain the development peculiar to the north, nor do the feminine virtues equal those of

the south ; but the opposition between them is productive of more unhappiness in French domestic life than is to be found in either of her neighbours.

In the different points of view in which we have considered the human development, there are distinct and important differences between the three nations which we have contemplated ; France being characterised by a pre-eminence of no one quality, but by the existence and opposition of extremes, the chief development of each of which is to be sought elsewhere.

By moving eastward on the chart, and considering the Germanic races from Sweden and Norway down to the Alps, and the Italians, we find an analogous transition from the circumstances stated as characteristic of English civilisation to those described as essentially Spanish, but neither extreme attains so great development as in the first-considered group. The German character may, I think, be correctly described as connecting the French and English, as politically the division of the country into numerous states, corresponds to centralisation greater than in England, where authorities are essentially local, but less than in France, which is the type of powerful centralisation. The Germans are remarkable for their profound and abstract reasoning, and probably love science more for its own sake than any other nation.

In like manner the Italian is intermediate between the Spaniard and the Frenchman, and is distinguished by faculties which belong to neither, but which pass over to theirs in opposite directions. He has neither vanity nor pride, is little disposed to communicate or even acknowledge his thoughts, and has hence been

called treacherous ; wanting in that strength of passion and personal dignity which are so striking in the Spaniard, but in richness of imagination he stands equally alone, and Rome will ever be the head quarters of Art.

This rapid and imperfect, but I trust not incorrect sketch of the characteristics of the five nations which are usually considered to form the vanguard of civilisation, establishes the existence of great and profound differences between each of them. In order to solve our question, whether the tendency of the natural laws is to increase or diminish distinctions of national character, we must now examine a sufficient period of the past, to see whether they have been increasing or diminishing.

We will again begin by considering relatively France and England, and it is easy to see that in the centuries in which the Catholic and feudal system was common in both and in full action, the difference both of minds and manners was far less than at present ; the very fact of the same spiritual and temporal constitution being common to both, bears testimony to this. The languages, now so distinct, were then far less developed, and but few centuries further back, at the time of the mission of St. Augustin to convert the Saxons, we learn that the Franks, who spoke the same language, served as his interpreters.

If it is true that the genius of a population may be studied in its social and political institutions, it is certain that the distinctions we now perceive between these two populations then existed only in germ. The various tribes which possessed the territory now called France, had much in common, and were in general

more connected with one another than with the exterior; but the independence they possessed was sufficient to render their partial submission to a common authority, rather an act of allegiance than amalgamation,—in a word, the vigorous body now constituting France did not then exist, but its elements are to be found, and a tendency to union between them. In like manner the British character as we now see it, and the British nation as it now exists, are the product of a long series of events and influences, of which many are posterior to the period we are considering, while the effect of others has been developing.

Thus the Norman conquest laid the foundation of our present constitution and of the strength of the aristocracy, for while necessarily united by a strong bond of common origin and interests, William's barons were allowed from the first a degree of independence, and even license, which under other circumstances would have degenerated into isolation. They acknowledged the royal authority and prerogative, that it might support their tyranny of the people, and attained a degree of local power elsewhere unequalled. But this being in the course of time firmly established and acknowledged, their successors began to turn their attention to lessening their subjection to the chief central authority, which had been necessary while their local positions were yet insecure. To accomplish this object it was necessary to have the support of the people, which could only be secured by the encroachments of the nobles on the royal prerogative being directed to points of general benefit and interest.

The feudal nobles of France were, on the contrary,

the native chieftains of the soil, and were held together by no such powerful material tie of interest as the Norman usurpers. They granted less power to their king, because their local authority stood not equally in need of his support, and having less support from the central power, their local dominion became less firmly and deeply engrafted upon the people. But resting themselves on traditional origin, they gave an example of respect to the principle of established subordination, and their allegiance to royalty was indispensable for the support of their individual positions ; but it was a spiritual support they derived from it, not, as in England, a material one.

We must not, however, consider the circumstances just alluded to simply as the causes of the opposite tendency of development ; it is equally correct to see in them the expression of the state of mind of the respective populations. It would not have been possible for William the Conqueror to establish the feudal system with such intensity in England, had not the genius of the population been adapted to such an institution ; and the power obtained by the nobles in their dominions, is an evidence that the people was chiefly disposed to acknowledge local authority. It looked to practical and material amelioration of its condition, and as the nobles were aware that this was the proper basis of their strength, it became accustomed to consider them as its leaders and protectors.

With our neighbours the case was quite different ; for possessing the soil by what was believed divine right, the French nobles considered their peasants as made only for their service, and so cruelly oppressed

them by their tyranny, that the poor peasant gladly advocated the extension of the principle of divine right which imposed upon the nobles the check of the royal authority.

The distinction is striking between the two populations. The English accomplished directly and practically, by conciliating their nobles, what the French endeavoured to arrive at by the more indirect way of appealing to a principle of which the immediate influence was to increase the alienation and cruelty of their local chieftains. By the English practical mode of proceeding, the special was the basis upon which they started, and gradually arrived at the more general result of regularising royal authority ; whereas, in France, a general principle was the starting point, from which they endeavoured to obtain useful applications to their individual and special condition.

We thus find that the Catholic and feudal system, when at its height, showed evidence of the existing distinctions between these two countries ; and by following down the comparison to the present time, we find the opposition of direction becoming more and more apparent and active. In France the authority spontaneously granted to the king by the nobles, gradually increased, until, under Louis XI., royalty actively took up the task, and ultimately reduced the nobles to mere servants of the crown : whereas, in England the contrary tendency is equally clear ; for once firmly established by the aid of royalty in their possessions, the nobles continually grew in power at the expense of the crown, till it finally assumed the position of a head of the aristocracy.

Royalty in France became more and more identified with the capital, and the supremacy of Paris over the other towns of France was finally established, when the nobility was collected around the royal person in the form of royal livery servants. But Paris became aware of its position, and at length emancipated itself from the institution of royalty, which after rendering such eminent services, had become an impediment to further progress.

We saw that the French are characterised by vanity, and that for them a thing is good only in so far as it resembles themselves. They now most firmly believe that we are behind them on the same road, and shall pass through a similar revolution ; but in this, as in other judgments of England, they are destined to find themselves mistaken ; and it is as much in their interest as our own that they should be so disappointed. I attach some importance to the proof I am about to give you of this fact, because it seems to me to concern equally men of every station in life, political or religious party, and to tend directly to increase their practical union upon the basis of individual freedom and responsibility, by showing that their apparent oppositions are but the workings of the vast machinery of advancing themselves and their species ; and that, whether they will or no, they concur in forwarding one vast and common movement. I say, *increase* the practical union of men ; for, truly, a practical union already exists between us all, however independent our individual convictions may be, but I will venture to advance, that in no country does it exist in so eminent a degree as in our own glorious Fatherland,

yet in no country is there more need of its extension and consolidation.

But if any one place be more adapted than another for the contemplation of this elevated subject, it is surely the College in which we are now assembled ; for it is the first, and as yet, the sole institution which dares to enter directly and openly upon the greatest and noblest of human problems—uniting men for their mutual benefit, upon the basis of morality and truth, and leaving to the conscience and discretion of each the forms and applications.

Every one has benevolence enough to wish to have more. If we could see that the apparent opposition of men's efforts is but the machinery by which a movement and improvement common to all is effected, surely the foundation would be laid of a more extensive benevolence ; but if men could be convinced that the practical desire and habit of doing the utmost good to others in their power, is, of all methods, that best calculated to produce happiness and benefit to themselves individually,—then, indeed, and not till then, they would be truly benevolent. Yet this is true, and may be demonstrated with scientific rigour, as it may be verified by the observations of every individual. The scientific proof consists in establishing the identity of the highest inductions in the event of the human development, with the spontaneous conclusions of a truly benevolent mind ; in showing that the most important moral precepts are but practical truths susceptible of verification ; or in removing the metaphysical distinction hitherto maintained between the *heart* and the *head*.

The verification is easily made by observing that a

man whose conduct gives evidence of a sincere desire to do good to others, is always sooner or later advanced to a position where he can best accomplish his object, and rewarded by the love of his fellow-men. The present instance affords us illustration of this identity, and by the aid of the preceding considerations, a distinct, though necessarily general, solution of the question by which we entered upon this discourse: namely, the future destinies of England; for it is evidently impossible to tell what will be the stages of her onward progress before we know her destination.

Her characteristic as a peculiarly Protestant country, is a co-existence of the most various individual convictions; but it is most important to remark that this very variety is the basis of the firmest existing practical union of action. Nobody who has had occasion to compare the faculties of the French and English, can, I think, have failed to observe the rapidity of conception and reasoning which characterises the former, and from which *we* are, as a nation, perhaps the furthest removed. Their minds and language are, indeed, eminently adapted for arranging and exposing facts in the most clear and striking manner. On any subject of contemplation, a Frenchman instantly forms, with the facts before him, a theory, by the aid of which he then proceeds to a further examination, and soon finds reason to substitute another for it. His mind is at once made up upon any subject—that is, he forms at once some conception, which serves him more or less well, to explain the matter in question.

An Englishman, on the contrary, is remarkable for

the slowness with which ideas present themselves to his mind : he attends very carefully to the facts of a case, and the idea he forms upon them has always a practical object and application, which he in fact generally realises. Indeed, his standard of judging of the truth of an idea, is the success of its application ; and the concrete existence to which he gives rise, of a general fact, is the sole decisive proof of its reality.

Now every one may understand that a compound object may be analysed ; that is, an object being known, it may be explained what are its component parts, and how they are connected. Thus, a horse having been seen, it may be explained that he is composed of certain animal organs, arranged in a certain manner ; but the same thing may be done with an idea, which is the more or less defined representation in the mind of an exterior object ; it may be analysed into its elementary parts.

Ideas only differ from other sensations by their lesser precision—they are nothing but imperfect representations of the impressions we receive from exterior objects. After looking at a horse we retain for a longer or shorter time a representation of him in our minds, but necessarily less distinct than that we obtain from direct inspection ; this representation we call our idea of the horse, but it is a special idea. If we were to see a white horse, and then a black, and then a grey one, we should find in each successive impression, much resembling the former one, but the circumstance of colour different. It is this omission of one or more elements from a series of special ideas, so as to retain only that which is common to

them all, which constitutes a general idea. In like manner, by singling out from several general ideas that which is common to them all, we form a still more general idea. The idea of horse and that of a dog have certain elements in common, and this still more general idea we represent by the word animal.

Thus it is evident that the operation of generalising ideas consists in finding out that which is common to various impressions ; and a person has a general idea only inasmuch as he looks at the resemblance of objects.

Now it is this faculty of seeing *resemblances* with great rapidity which constitutes the French power of generalisation, and the habit of grouping objects according to their resemblance, which gives such simplicity and consequent clearness to their ideas and expressions. The unity of their institutions is but a concrete representation of this same phenomenon, and a necessary complement of it.

The syllogism in its most general form is nothing else but the operation of connecting ideas by a common circumstance. Thus, when we say : All oppositions are evils and as the actual relative state of France and England is an opposition, it is an evil, we assert that the fact of being evil is common to "all oppositions," and "the actual relative state of France and England." The form of affirmation is necessarily analytical—it is analysing the idea of an opposition to say that it necessarily contains evil, and an analysis of the actual relative state of France and England is necessary to discover in it an opposition : the premises are merely affirmed, not proved ; though it is often supposed, that the conclusion being found true, may react in proof of the correctness of the fundamental

affirmations. Indeed, it is a peculiarity and imperfection of the analytical mode of reasoning, that simply affirming its premises, it rests for all proof of them on repeated verifications of its conclusions.

It is, I believe, now generally admitted of the syllogistic form of reasoning, that it has served and can serve only for negative purposes, and is not the vehicle of extending our knowledge in any one direction. The same is true of the analytical or deductive method in general, which, by showing the elements of a compound idea, opens the road to criticism and scrutiny.

But what I would wish especially to bring under your notice, is the fact that the mechanism of the analytical process is nothing more than a discovery of partial similarities between ideas ; for we are only able to separate mentally one component part of an idea from the rest, by perceiving a resemblance between this component part and something else. Our analysis of the organs of animal life has only been effected by the comparison of various species, between which we found certain facts in common.

Thus it is that the habit of especially seizing resemblances is necessarily represented by an analytical mode of exposing ideas.

We have seen that the French are remarkable for their uniform habit of seeking resemblances ; it is easy to complete the observation by showing that their form of argument is analytical and deductive, and is attended by the evils and advantages inherent to that method. To everybody sufficiently acquainted with the writings and influence of Descartes, I shall

give at once an illustration and evidence of this fact by simply recalling his name. Affording no proof, even when he strove most to do so, of his general principles, he is truly remarkable for the extensive and acute analysis he made of their consequences. Of his fanciful generalisations in science, nothing has remained but the negative influence they exercised in decomposing and removing old and worn-out theories, and the habits of mind which he so powerfully developed among the French. So truly did he indeed represent the tendency of the French mind, that he has ever since been the chief representative of their most advanced thinkers, and he is to the present day considered by them to have opened up the era of modern philosophy. Though in the general sense in which it is asserted, this is certainly inadmissible, it is eminently true from the French unique point of view; and Descartes will ever be taken as a characteristic and noble type of French or analytical reasoning. A still more decisive, because more precise proof, is afforded by the development of the analytical method in mathematics among the French. The various transformations of an equation have no other object than to bring to light the various truths contained in that general enunciation, and the French philosophers generally attempt no other proof of the correctness of their equation than in its application; witness Fresnel's optical researches.

I explained to you that the power of abstraction in its greatest development is nothing else than the faculty of keeping in mind continually one image to the exclusion of others, and that the habit of abstrac-

tion consists in seeing phenomena only inasmuch as they resemble this image.

The human mind is only capable of containing one image at a time ; but this image may be simple or complex. It is by their faculty of finding in various phenomena some common circumstance, that the French are able to consider them simultaneously, though necessarily partially or by abstraction. A grouping of these various phenomena is thus effected, but from the one-sidedness of the view upon which it is made, an abstract or imperfect one.

The French are remarkable for retaining the same idea long in their minds, and by finding its representation in a vast number of phenomena, discovering such an abstract connexion between them. But they pretend to more than this, and by the aid of the abstract connexion of phenomena, they assert their power of giving concrete or practical directions, and even undertake their realisation.

It is the necessary one-sidedness of the special views thus deduced from their general principles which leads to their uniform failure.

No nation has such positive inaptitude for construction, of whatever nature, as the French, because no other nation conceives it practicable upon a one-sided view of facts. But I will show you that far from being an evil, as one might at first sight be disposed to consider it, this circumstance is the very foundation of the greatness of France, and of the eminent services she is destined to render to Humanity. Questions must be raised before they are solved, and it is the function of France in the economy of Europe,

to raise the most opportune questions, and urge to their practical solution.

Man cannot create or destroy—he only combines or separates. The faculty of combining various circumstances is often called construction, that of separating them, destruction. We saw that the analytical process is a separation, hence its negative effect. The synthetical or inductive method is that of construction. Its direction is the reverse of the preceding, and its results opposite. We cannot unite a thing with itself, but with something else. Thus it is that the synthetical method requires the connexion of differences, as the analytical that of resemblances—and reciprocally the habit of considering the differences of facts is the turn of mind of the inductive thinker, as that of finding resemblances is the characteristic of deduction.

We noticed the intellectual faculty of the Frenchman of retaining long an idea in his mind, and finding extensive instances of its representation. The reverse is true of the English character, and his disinclination for abstract ideas is accompanied by the corresponding habit of passing to a new concrete consideration, as soon as he has become acquainted with one.

The French standard of force of intellect is simply that continuity of direction, and to them the want of change of occupation experienced by an English mind, is an indication of lightness; and here, as usual, their intended solution is merely a criticism which serves to prepare the question for a mature deliberation.

If synthesis consists in connecting various distinct ideas into one compound idea, it is evident that the mental operation by which it is effected, must be preceded by a successive consideration of each of these compound ideas, and the more rapidly the mind can pass from the study of one to that of another, the more easily will it be able by retrospection to combine them. The faculty and habit of rapidly passing from one idea to another entirely distinct, belongs therefore to the inductive reasoner ; and by considering it a sign of weakness, the French give us a new evidence of their inverse habit of mind, and accompanying vanity.

Every one is aware of the great effect of applying a power of mind or body upon the development of that power, that on the one hand a highly developed faculty may by disuse be much enfeebled, as on the other a frequent exercise strengthens and extends such powers as we possess. This simple and popular truth is of much scientific importance, for it explains to us the connexion between the peculiar habits of mind and the activity and consequent institutions of the nations we are comparing.

The different direction of mind which I showed you to exist in the middle ages between the English and French populations, was accompanied by a corresponding direction of the activity of each, and the institutions which are the most general concrete result of this activity, reacted both upon the minds and manners of each population. The habit which the French contracted of looking to the king as representative of the principle which protected them, made them favour the development of the royal authority ;

and in proportion as this increased through their support, did it re-act upon the principle on which this support was founded. Not only did royalty see its interest was to restrain the oppressive power of the nobles, but by its fastuous displays and splendour, it excited the vanity of the nation, and brought in this new lever to act powerfully in the same direction of centralisation and unity.

A quality of mind or of body *only* develops by practice, and when we find any peculiar faculty in an individual or in a nation, we are sure by attention to discover in the surrounding medium a series of circumstances corresponding with this faculty, effects of its exercise, and causes of its development. Thus our ancestors, possessing in a lesser degree the faculties of mind which I have described as now peculiar to the English nation, directed their conduct according to them, and the result of this continued action and corresponding re-action, has been the present inductive and practical turn of mind, and institutions systematically calculated for practical and gradual progress.

We thus see how each peculiar turn of mind is necessarily accompanied by a corresponding activity. The thinker, accustomed only to generalisations, is directed by an abstract principle, and his activity is that of a theorician ; having but one distinct idea, he judges of everything according to it, and not understanding whatever is in disaccordance with it, he sees harm in every union of dissimilar influences, *i. e.*, in every existing union except that upon which his ideas are formed, and his activity is directed to dissolve them.

This is the French character and influence.

The practical character, on the contrary, has a

distaste for abstractions and generalisations, but is attentive to their analytical deductions. He attaches more importance to the certainty than extent of a fact, and certainty is in his mind a relative phenomenon. He considers every proposition as incomplete which contains but similar and homogeneous elements, and beginning where the Frenchman ends, he combines these one-sided truths into mutual action ; and his demonstration of the truth of his mental combination, is no other than the inspection of its concrete existence and result.

This is the English character, and this is the part it has been more and more systematically playing in the economy of Europe.

The difference between the French and us, is the difference between theory and practice ; and it were as impossible to take from France her power of raising questions and stimulating men's minds, as it would be impossible to take from England her function of solving questions and directing men's activity. Nothing that France does can be definitive, and nothing can England do, but on the basis of her attempts ; for deductions from an abstract principle never can be else than one-sided views of facts, and a combination of a variety of these is necessary as basis of the induction which alone establishes.

The distinctions which I here draw, are of course relative and not absolute, as my conclusions consist in establishing a relation and no independent or absolute fact.

I must here make a remark concerning the nature of the inductive method which I have considered in a somewhat different light from that which is, I

believe, now usual. In France, induction is considered by the few who use the term, as a conclusion on analogy. Thus, if a certain number of terms of a series be given, of which the succession is according to some known law, induction would for a Frenchman consist in extending this same law to the subsequent terms. Now I do not use the term in this sense, which, indeed, appears to me nothing else than a peculiar form of deduction, since its leading principle is resemblance or unity. Induction means to me a concrete and special operation, and not one resting on any consideration common to a series of facts. Its characteristic is the union of distinct parts into a whole. It therefore requires the material juxtaposition of these distinct parts in the appropriate order, and the observation of their mutual action, which is thenceforward represented in the mind as a distinct image. I stated that our ideas have *no other* source than our impressions of exterior phenomena; we have here a verification of the truth of that statement, as, by the inductive process which establishes all our ideas, each step is made simultaneously with the realisation of the corresponding exterior phenomena. Analogy, *i. e.*, consideration of resemblances, guides our minds to the subject, and furnishes us with an hypothesis which we verify by combining the circumstances necessary for producing the true phenomena. Our sensation from this, inasmuch as it differs from that produced by other phenomena, is a new idea.

Of course I consider collective and not individual man. The impressions received by each individual are communicated to the rest of the social body.

directly and indirectly, by language in its various forms and degrees, and by the corresponding actions.

I have endeavoured, by the above *juxta-position* of facts, to answer the several questions which presented themselves at the beginning of this discourse ; the conclusions I draw may be confirmed, if true, by a study of history and an inspection of existing realities. Our knowledge is necessarily limited to what has existed or exists, and a careful analysis of the general facts common to the past and present, may show us part, but only part, of the future.

Thus whatever order of phenomena we contemplate, we find, provided a sufficient extent of it be considered, that the difference or variety of characteristic constantly increases between individuals and individual activity, and between nations and collective activity and the corresponding institutions, and it is utterly impossible for us, without denying or neglecting facts, to conceive the future based upon the past and present otherwise than by further developing these distinct varieties. As an instance of this difference, we are similarly obliged to believe that the mode of development of France, now so opposite, will be more and more distinct and different from our own, and we admit this conclusion the more willingly, as we see that this distinction is the basis of our mutual strength and utility. If the facts I have brought forward be true, it would be as irrational to attempt to advance the British empire, by mere imitations of the French or any other nation, as to try to alter the law of gravitation.

The English are destined to govern mankind, and they will arrive at this position in proportion as they

give evidence of the power and the will to do good to mankind, on the basis of the development of its various parts. We have seen that it is the spontaneous concourse of a vast number of individual efforts to one common object which is advancing this great event.

The precepts of morality and virtue are but truths of the highest order, and, like all other truths, are felt before they are explained, are explained before they are proved by their complete application; the deductions formed from them, or their analysis, is the operation by which they are explained—to this succeeds the inductive realisation and proof. But their realisation necessarily and powerfully re-acts upon the strength with which they are felt, and the circle thus recommences on a more extensive scale. Now this, as every true idea, corresponds to a concrete phenomenon, and is proved by the inspection of that phenomenon. In characterising the relative peculiarities of the three western populations, Spanish, French, and English, I showed France to be an intermediate term between the two extremes. The functions which the three nations fulfil in the economy of the human species, are in accordance with their relative aptitudes. The Spaniard is remarkable for the personal and intrinsic dignity of his nature, unsupported by exterior power or influence. He is so naturally disposed to admit the moral rules on the assurance of men whom he venerates, that such proofs by which they may be accompanied occupy him little; he feels strongly but thinks little, and is willing to leave all activity and the accompanying responsibility to others. He may thus be considered the type of the

working man, contradistinguished from the capitalist or philosopher.

France, on the contrary, has activity both mental and material, and the co-existence of this with a considerable amount of the Spanish feeling of fraternity, gives rise to her pretension to an absolute superiority, if not supremacy, over all other nations. She attempts to explain and extend the moral principles which the Spaniard feels so strongly, but her analysis serves only to destroy the explanations given, and thus prepare for a new one. Her citizens have less individual than collective liberty, and have synergy but not energy: her influence is spiritual.

England receives truths neither from their beauty as the Spaniard, nor their necessity, as the Frenchman. Truth alone, according to individual conviction, is the basis upon which the Englishman advances, combining the wants and feelings of the one party and the reflections of the other with a direct observation of the material forces at his disposition, he realises such improvements as are compatible with these various elements. The Frenchman's criticisms and antipathies are to him phenomena indicative of the subjects on which improvement is needed. The Spaniard's fraternal spirit and love of repose remind him that they should be directed to increasing the welfare of the mass morally and materially, and the experience acquired by past efforts is the basis upon which he works.

The Spaniard feels, the Frenchman explains, the Englishman realises.

According to the present constitution of society, her appreciation of the value of services rendered

her is conveyed by two vehicles: money, which is a representative of the material value set upon a service, and consideration or respect, which is the corresponding return for moral and intellectual services. As all effects of the exercise of one's powers re-act upon the development of those powers, so do services rendered to society re-act in these two ways upon the individual who performs them. Wealth gives a man the material power of rendering new services to society, as the esteem and respect with which he is regarded, gives him the power of improving men's ideas and feelings by affording them moral and intellectual instruction.

From these facts we conclude that the population best adapted for the realisation of material benefits to society, will necessarily become more and more the depository of the money, and thus direct the varied operations of human industry.

An intermediate term between this governing body and the governed masses, is the self-termed spiritual class, destined to stimulate each extreme in the direction in which it should move. The Frenchman's point of view is the subjective necessity, as the Englishman's is the objective reality. It is easy to retain the meaning of this important distinction, by remarking that the French mind is so constituted, as, without changing subjects, to pass rapidly from object to object, whereas the Englishman combines the consideration of various subjects for one object.

Let us now consider what practical conclusions we may derive from the above considerations for the guidance of our conduct, for, truly, speculations are only useful inasmuch as they lead directly or indi-

rectly to practical improvement. The highest, and, I may say, only result, is to make us *see* what, in various degrees, we have long since *felt* to be true, and what all forms of religion concur in inculcating —the maxims of benevolence and disinterestedness, *i. e.*, of true morality.

Every individual feels that he ought to cultivate benevolence towards his fellow man, and to do him as much good as he can; and every nation acknowledges similar obligations towards her sister nations: but these virtuous feelings can only attain their highest development in proportion as it becomes evident that those peculiarities which the ignorant blames and accordingly hates, are, in truth, the very elements of our individual and collective improvement, and that the conduct best calculated to do good to others, is necessarily that most favourable to the prosperity and happiness of the individual. To withhold knowledge, is practically to assert that morality and virtue are not founded on truth, and consolidated by every positive extension of our knowledge.

The more we understand, the more truly we love and admire, and, consistent to this principle, the Englishman will learn to appreciate the contrary qualities of criticism in the French, so eminently useful in their connexion with us, though alone they would be inexcusable and even hateful.

I am aware that the nature of this discourse, in as much as it takes effect, will tend to excite your ambition, but it does so only by showing the road to the objects of ambition, by proving to you that the more material good you can do, the greater will be your material power, and the more you can stimulate

and develope the benevolent and virtuous feelings of mankind, the greater will be its esteem and affection for you.

As Englishmen, you must do more good than can be expected of any other nation ; and the standard of judging yourselves must be higher than that by which you judge of others.

You have, however, peculiar advantages, and consequent responsibilities, from the fact of your studying in this institution, and I trust your conduct will show that you are conscious of both. The existence of this College is a national declaration that the time for opposing one another is past, and that union of differences is now the order of the day ; and this act of truly practical morality is one of the noblest proofs of the reality of the tendencies I have so imperfectly explained to you. I would wish you to feel that the eyes of England, and, indeed, of the civilised world, are upon you, and that you are responsible for proving, by your lives and conduct, that the problem we undertake is practicable. It would, however, be quite in contradiction with the principles I have exposed, were you to harbour any feeling of jealousy or ill-will towards Colleges of which the principle is less directly moral. Indeed, the effect of all attempts at producing impossible resemblances is so universally to increase diversities, that we ought to look upon institutions of that character in the same light as that in which I have described France—namely, as forerunners, of which the influence is necessary to prepare for the union of differences which we directly undertake. To love an enemy whom we consider as such, is, at least, difficult ; but it is not at all difficult

to love a man whom we perceive to be doing us constant good, though he fancy himself our enemy. It is thus that we may solve a hitherto almost enigmatical problem.

You are probably aware that the studies which occupy you here, do not supply you with all, or nearly all, the knowledge you need in your final pursuits : their chief benefit is to increase your powers of acquiring and applying knowledge.

The courses belonging to the faculty most appropriately termed that of Arts and Laws, combine, in various degrees, an exercise of the corresponding mental functions, viz., Art and Science.

Art may be described as the faculty of conceiving and communicating imagery, as Science is that of connecting impressions by their mode of succession, which mode of succession is termed the law of the phenomenon. An impression must, of course, be communicated before its connexion with others can be explained : thus Art prepares the way for Science. But the better the connection between impressions is known, the more distinct does each of them become, and the more impressively can they be communicated : thus Science reacts upon Art. The most characteristic of arts is poetry, as the least artistical of sciences is mathematics. The former communicates sensations, as the latter exposes the necessary laws of connexion. There is more science in music than in poetry, and still more in architecture ; as, on the other hand, natural philosophy, treating of more complex existences than points, lines, surfaces, &c., contains more art for the communication of its phenomena than is the case with mathematics.

And again, history, treating of the connexion of still more complicated facts, requires a far greater amount of art. But in proportion as Art develops, does it consider the more general impressions of individual, and finally of individual and collective man ; so also does Science gradually discover more and more general laws. Having begun by expressing the most elementary passions and sensations of men, poetry now enters upon the noble and generous sentiments which inspires masses. Science, originally discovering laws only in the simplest phenomena, has constantly advanced to more and more complicated ones, in proportion as Art obtained sufficient development to communicate the corresponding phenomena. Hand in hand with these mental operations has moved their application to our activity. The useful arts at first directed to the satisfaction of immediate individual wants, became gradually more general and social in proportion as we learned to understand more complicated phenomena, and they reacted upon the development of our understanding.

Before concluding, it will probably be expected of me to say something of Chemistry—a science of which the development has, during the last half century, been so rapid, and of which the results have found so many valuable applications in the useful arts. One circumstance must, I think, have struck every attentive observer of the modern movement of science, and that is the frequency of the aggressions which Chemistry has been making on the domains of her sister sciences. These aggressions have, indeed, been so frequent as to cause no little trouble to the culti-

vators of these sister sciences, and to give them almost constant occupation in repelling them.

Chemistry is the elementary analysis and synthesis of matter, as mathematics is the elementary analysis and synthesis of ideas. The domain of mathematics has been constantly increasing at the expense of other sciences by reducing their laws to numerical facts. Chemistry has advanced from the analysis and synthesis of the simpler substances, to more and more complex ones, and her attempts to take in phenomena of a higher order, are often, for a time at least, repelled by physiologists and pathologists. It is not difficult to see that in proportion as our methods of separating and putting together elements become more perfect and extensive, it will be possible to analyse and prepare more and more complex and varied substances. But if it be true that we can only destroy by separating, and can construct only by uniting elements, then, indeed, we are forced to admit that our fundamental power over natural phenomena is in an application of chemical analysis and synthesis, and that its greatest development is to be expected from the improvement of those methods.

I would willingly enter more fully into the explanation of this my Science of predilection, but such explanation would belong rather to the courses on the Science itself, than to a discourse common to them and many others.

General considerations are, however, only destined to open up questions to our minds, and are useful in proportion as they serve to guide each to a point to which he may most advantageously apply his activity. Success is only obtained in any pursuit by the power

and perseverance which one devotes to it; and if the above serve to stimulate your exertions, and make you profit to the utmost of your powers by the preparatory exercises which here occupy you, I shall have accomplished the immediate object of this address.

THE END.